The FOUNDRY

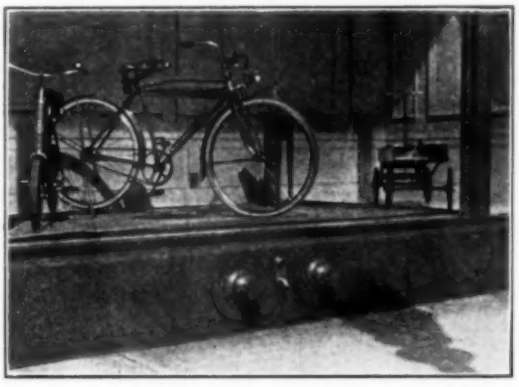
Volume 57
Number 13

Published
Semimonthly

CLEVELAND, OHIO, JULY 1, 1929

Castings Aid in Reducing Fire Fiend's Havoc

MODERN office, apartment, hotel department store and factory buildings, boldly outlined against the skyline, appear impregnable to storm, water and fire, particularly when their steel skeletons, concrete floors, and stone or terra cotta exteriors are considered. Although the buildings are practically as fireproof as modern con-



Exterior Outlets and Other Building Fire Fighting Equipment are Made from Castings

struction can make them, owners are haunted by the vision of that red specter, fire. This is due to combustible materials such as wooden office and home furniture, books and papers, oil soaked machines, etc., housed in the buildings. In days past when buildings did not exceed three stories in height, in case of fire, firemen dragged hose through the building to the seat of the fire. Now, with 5 to 50-story buildings containing a maze of corridors, rooms and connecting passages, a small blaze could become a raging holocaust before the firemen could lay enough hose to reach it. Therefore, buildings are equipped with automatic sprinkler and standpipe systems located in advantageous sections of the buildings. The standpipe systems have outlets on the exterior of the buildings at street level to which lines are attached from the pumping engines of the fire department and inside openings on each floor. Valves, hose nozzles, interior openings, and exterior connections are castings.

Find Where Castings Can Be Sold

CONTENTS

FEATURE ARTICLES

	Page
Gray Iron Foundry Specializes in Pistons	546
Strength and Ductility Are Affected by Thickness and Heat Treatment—By A. J. Lyon	550
Producing Steel Castings in the Modern Foundry—Part III—By Charles W. Veach	554
International Exhibition Shows Foundry Progress	557
Foundry Party Tours England and Scotland	561
Control Features New Type of Open-hearth Furnace—By Norman F. Hindle	568
Test Bar Results Approximate Properties in Casting—Part II—By John W. Bolton	572
Bill Describes Mold for Hydraulic Cylinder—By Pat Dwyer	576
Melting Iron in the Cupola—Part XXI—By J. E. Hurst	579
Adopts Standard Sales Agreement	581
Gas-fired Tunnel Kiln Provides Continuous Malleable Anneal—By J. B. Nealey	582

REGULAR DEPARTMENTS

Questions and Answers on Foundry Practice	564	**Trade Trends in Tabloid**	585
Problems in Nonferrous Founding — By Charles Vickers	567	**Comings and Goings of Foundrymen**	586
The Shakeout	584	**What the Foundries Are Doing**	590
		New Trade Publications	590

—⊡—

PUBLISHED BY THE PENTON PUBLISHING CO., CLEVELAND, O.

BRANCH OFFICES

CHICAGO ..... 1347 Peoples Gas Bldg.
CINCINNATI ..... 209 Edwards Bldg.
NEW YORK ..... 2208-2206 No. 220 Broadway
PITTSBURGH ..... 2148-49 Oliver Bldg.
SAN FRANCISCO ..... 24 California Street
WASHINGTON, D. C. ..... 1653 Pennsylvania Avenue
LONDON, ENGLAND ..... 416-417 Caxton House, Westminster, S. W. 1
BIRMINGHAM, ENGLAND ..... 14 New Street
PARIS, FRANCE ..... No. 9 Rue de Londres
BERLIN, GERMANY ..... Wilhelmstrasse 114, Berlin S. W. 48

Cable address, IROTRAPEN, London

SUBSCRIPTION

United States and Mexico ..... $3.00 a year
Canada ..... $4.00 a year
Great Britain and other Foreign Countries ..... £1:0:0 a year
Single Copies ..... 25 cents

Copies published three months or more previous to date of current issue, 50 cents each.

Member, Audit Bureau of Circulations, Associated Business Papers Inc., National Publishers' Association

The A. B. P. is a nonprofit organization whose members have pledged themselves to a working code of practice in which the interests of the men of American industry, trade and professions are placed first—a code demanding unbiased editorial pages, classified and verified subscribers, and honest advertising of dependable products

Copyright 1929 by the Penton Publishing Co.

Gray Iron

Foundry Specializes in

Makes Over 350 Different Types of Pistons for Trucks, Automobiles and Tractors in 70 Ton Capacity Foundry

ABOUT seven years ago, H. R. Street and J. S. Parker organized the Parker-Street Castings Co., Cleveland. A building, 90 x 140 feet, with two wings for the cleaning room, coreroom and engine room was acquired for the casting operations. The building was located on the outskirts of Cleveland, along the Pennsylvania railroad. On March 15, 1922, the first heat was tapped and the company began operations. The tonnage at first was about 15 tons per day.

As time passed the business of the company increased and larger quarters became necessary. Early in 1928, a three-story plant and office building, 60 x 90 feet, was added to the old foundry, and six months ago a new cleaning room was built. New equipment was purchased from time to time and more men added to the personnel until the company now employs 110 men, including 50 molders. The tonnage also has increased from 15 tons to 25 to 30 tons per day, with a total capacity of 70 tons per day.

The Parker-Street Castings Co. specializes in the manufacture of automobile piston castings. Over 350 types of tractor and automobile pistons are made by the company. Some idea of the variety of sizes, etc., may be found in the accompanying illustration. The large piston is for an engine of a Holt tractor and the one resting on it is a Chevrolet piston, which will be described in the process of manufacture later in this article. The company also makes pressure, ice machine, and experimental engine castings. Only a small amount of jobbing work is done compared with the number of specialty castings made in the plant.

The main foundry building, 90 x 140 feet, is shown in Fig. 1. As may be seen from the illustration, the molding machines are situated along the walls of the building on the south side, to give the workmen more light and to allow more space for the molds. In this part of the foundry various kinds of pistons are made. The foundry is equipped with 40 rollover type machines made by the Osborn Mfg. Co., Cleveland, 4 machines made by the H. E. Pridmore Co., Chicago, 6 machines made by the International Molding Machine Co., Chicago, 3 jolt squeeze type machines made by the Johnston & Jennings Co., Cleveland, and 6 power squeeze machines supplied by the Federal Foundry Supply Co., Cleveland. The remainder of the machines are power, jolt, stripping machines and were made by the Parker-Street Castings Co.

Two men are required to make a mold, one making the cope and the other the drag. The molds are made in such a way that they form their own green sand core in the drag. Three pistons generally are made in a mold, but on a few jobs the mold contains four. For large trac-

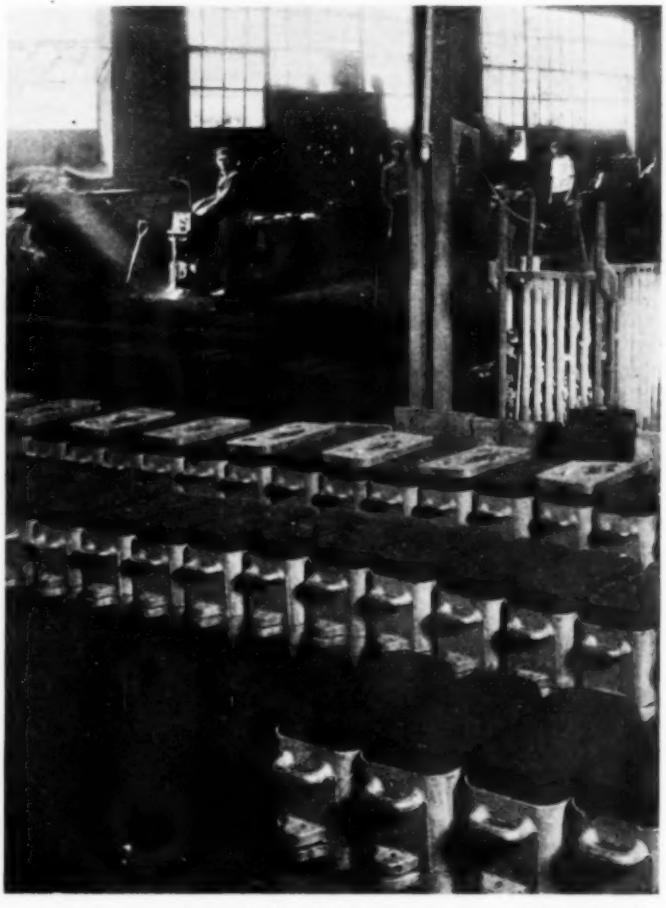


Fig. 1—General View of the Foundry Showing the

tor pistons, two castings are made to the mold. Each piston is fed from a special type gate designed by the company. In those molds where four pistons are cast, with the exception of the skeleton piston job which will be described later, the castings are staggered in the mold. Taper type slip flasks used in molding were made by the Hines Mfg. Co., Cleveland, and the American Foundry Equipment Co., Mishawaka, Ind.

Drags are made on rollover type molding machines. The pattern equipment used on these machines is of a special type and was designed by H. R. Street, president and general manager of the company. When the mold is being rammed, the drag flask rests upside down on the pattern plate. The cavities in the pattern which form the cores for the pistons first are rammed and a small rod is placed in the center core for support. The flask then is filled with sand and rammed by hand. After the bottom of the mold has been struck off the mold is rolled over and is ready for the final operations. The pattern is parted along its center line and when a lever is pulled the two halves are stripped from the green sand cores. This leaves the mold free from the pattern.

Orderly Manner in Which the Molds Are Placed

After that operation has been completed, the mold is dropped vertically by a lever on the machine. The mold then is placed on a small rotating table and is given a coat of blacking. It then is placed on the floor and is ready for the cope.

The copes do not represent as much of a problem as do the drags. Copes are made on jolt stripping machines. Since the copes contain only three cavities of cylindrical form, being the outside contour of the pistons with no intricate or irregular parts, they are rammed in the usual manner. When the cope and the drag have been made, the cope is placed on the drag and the flask stripped from the mold. The mold then is jacketed with equipment made by the Hines Mfg. Co., Cleveland.

Heap sand is used in making both the copes and the drags. Facing sand is rammed well around the pattern forming the cores before heap sand is used to complete them. Sand piles are cut over and mixed by hand and each day a wheelbarrow of new sand is added to the piles to keep them in condition. Burned sand is placed outside the building to be worked and again put into use.

The new foundry addition previously mentioned contains eight additional molding floors and is served by a 72-inch cupola recently purchased from the Whiting Corp., Harvey, Ill. The hand

molding floor is at the rear of the new addition and in a separate room. This is small as only about 1½ tons of the 25-30-ton melt are poured into that type work. The blast for the new cupola is furnished by a double impeller rotary blower manufactured by the P. H. & F. M. Roots Co., Connersville, Ind.

Iron for the main foundry is melted in a 42-inch cupola made by the Whiting Corp., Harvey, Ill. The cupola is situated on the north side of the main foundry building. Blast is provided to the cupola by a fan type blower made by the Clarage Fan Co., Kalamazoo, Mich. Ladles were supplied by the Whiting Corp., Harvey, Ill., and by the Federal Foundry Supply Co., Cleveland. The company makes its own hand ladles. Iron is transported to the various floors by a monorail system supplied by the Lowden Machinery Co., Fairfield, Ia.

Pig iron, scrap and coke are loaded into cars by hand and transported over a narrow gage track to a hoist type elevator which raises them to the charging platform. Here the charges are weighed on a scale made by the Fairbanks-Morse & Co., Chicago. The cupola is charged by hand.

An 8 to 1 melting ratio is used in the cupola which melts a semi-steel mix. The metal mixture depends on the class of work being poured. The steel in the mix consists of rail clips, angle bars or stampings. About 55 pounds of limestone per charge is used. Special alloy pig iron and nickel shot are used in some of the castings made here.

The engine room contains two compressors, one a 12 x 16-inch made by the Worthington Pump & Machinery Corp., New York, and the other a 10 x 12-inch compressor manufactured by the Ingersoll-Rand Co., New York. The former is in use and the latter is held in reserve.

The coreroom is small since few cores are required as has been stated previously. Two batteries of drawer-type, coke-fired, core ovens are situated along the west wall of the room. Each battery has eight drawers. A power riddle made by the Lowe Mfg. Co., Detroit, is situated between the batteries of ovens. The only cores necessary are those for the jobbing work and hand made molds. A paddle type sand mixer made by the American Foundry Equipment Co., Mishawaka, Ind., mixes the core sand.

Fig. 5 shows the cleaning room. The tumbling mills supplied by the W. W. Sly Mfg. Co., Cleveland, are shown in the foreground. Six of these are of the cylindrical type and the other two are rectangular. Two more mills will be added to the battery soon. A table type sandblast, made by the Pangborn Corp., Hagerstown, Md., is shown in the background, and a sandblast mill, built by the same company, is illustrated at the right. The table is of the continuous type. The dust arrester equipment was supplied by the Northern Blower Co., Cleveland.

Four grinders, two belt driven from an overhead pulley shaft, and two motor driven supplied by the United States Electrical Tool Co., Cincinnati, comprise the grinding equipment. A small hand grinder built by the Cleveland Pneumatic Tool Co., Cleveland, also is used in finishing the castings. After the castings have been cleaned they are heat treated at 1150 degrees Fahr. for one hour to increase the machinability. The final inspection and shipping departments are situated in the same room with the grinding equipment.

Two buildings outside the main foundry building, both 20 x 60 feet, house the pattern storage and the pattern and machine shops operated by the company.

The method used in this shop for the production of skeleton pistons for the Chevrolet automobile is extremely interesting. The pistons are molded on their side, four in a mold and green sand cores are used. However, neither the mold nor the cores are touched by the workmen. Two men make this type of piston, one making the cope and drag and the other the cores. The apparatus used for this job is shown in Fig. 4.

The machine on the left of the illustration makes the copes, the one in the center the drags, and the one on the right the cores. Copes and drags are made on jolt stripping machines.

While the cope and drag molds are being rammed in the usual manner by one man, the cores are being prepared by another man. The cores are rammed by hand, care being taken that the sand is rammed evenly in the intricate parts of the core.

Fig. 2—Cores Are Made in an Aluminum Core Box.

Fig. 3—Complete Mold Ready to be Closed with the Cores in Place

A small amount of sharp facing sand first is rammed around the contour of the core and then the remainder is filled with heap sand and rammed by hand. Each core is reinforced with two short pieces of iron rod and vented. Next the core machine is rotated through an angle of 90 degrees and the top half of the core box stripped off. The core box is shown clearly in Fig. 2. This illustrates the core box parted. When the cores are ready to be set the top half of the box, shown in Fig. 2, is stripped from the bottom which contains the green sand cores.

Describes Core Box

The downward motion of a lever raises the stripping pins. These are located between the core box and the outer casting of the machine. They extend to a level above the top of the cores as they lay flat in the core box. Two projections on the ends of the cope and drag flasks and the top half of the core box may be seen in Figs. 2 and 3. These projections rest on the stripping pins when the flask or core box is being raised or lowered into position. The guide pin of the drag flask fits into the hole in the bottom half of the core box seen in Fig. 3 and centers the drag flask with relation to the cores in the core box.

After the top half of the core box has been stripped from the lower half by lowering the lever, the drag flask is placed up-side-down on the stripping pins with the flask guide pins in the holes in the bottom half of the core box. The stripping pin lever is raised gently lowering the flask on the core box and placing the cores in the proper position in the mold. Core box and drag flask then are clamped together and are rotated through an angle of 180 degrees. The clamps are removed and the drag flask is lowered free from the core box with the cores set. Fig. 3 shows a mold about to be closed. Thus the mold has been made and the cores set without being touched by the workmen. Two men make about 160 molds per day of 8 hours or produce 640 pistons of the size and type shown in the illustration.

Fig. 5—Cleaning Room Is Small but Contains Sufficient Machinery for the Tonnage Produced

---

Linde Air Products Co., 205 East Forty-second street, New York, has opened two new oxygen production plants, one at 150 Stockton street, Jacksonville, Fla., and the other at 1000 West Washington avenue, Oklahoma City, Okla. The Jacksonville plant is in charge of E. H. Blount, superintendent, with J. Erskine district superintendent. F. K. Bucklow is superintendent of the Oklahoma City plant with A. B. Curtis, Dallas, Tex., as district superintendent.

Fig. 4—Three Machines Are Required to Make the Job. The One at the Left Makes the Copes, the One in the Center the Drags and the One at the Right the Drags

STRENGTH AND DUCTILITY

Are Affected by

Thickness and Heat Treatment

By A. J. Lyon

IN THE construction and repair of aircraft and aircraft engines, both for commercial and military purposes, heat-treated aluminum casting alloys are being used for many purposes. Examples are: crankcases, pistons, pumping and supercharger housings, gear cases, landing gear fittings, parts for the control system, gun tourelles, and brackets and fittings for mounting accessories. The high-strength casting alloys have replaced largely the better known alloys, such as the 8 per cent copper-aluminum, the aluminum-zinc-copper, the aluminum-manganese-copper, and the modified aluminum-silicon alloys, on account of the saving in weight and the increased reliability due to the improved physical properties of these heat-treated alloys.

Use Standard Gating Methods

Physical properties of cast alloys, for the purpose of drafting specifications, design calculations, and for the purpose of routine tests made as checks on foundry and heat-treating practice, are based on the results obtained from cast-to-size tension specimens ½-inch in diameter at the reduced section. These specimens are cast in separate molds with standard methods of gating, as shown in Fig. 1. In some instances test specimens are attached directly to the casting in the form of a coupon by a suitable runner or gates. However, this latter method, is not used by the army, navy, or principal manufacturers of aluminum casting alloys. It is well known that the principal factor affecting the strength of casting alloys is the rate of cooling in the mold after the metal has been poured. The rate of cooling in green sand molds, which form the bulk of aircraft castings for general purposes, is dependent upon the pouring temperature, size of casting, thickness of sections, method of gating, and the amount of chills that are used in the mold. It is the practice to pour at the lowest possible temperature and to use chills in place of risers wherever possible on heavy sections in the casting of these alloys; but it is not possible to obtain the same rate of cooling on a large and small casting, no matter what manipulations are used. The rate of cooling and the resulting crystal structure also have a pronounced effect on the heat treatment.

Data Is Valuable

DEMAND for decreased weight in aircraft and aircraft engines has led to the development of a number of light alloys which possess high strength after a suitable heat treatment. Some of these alloys are used in the form of castings and others are used as forgings or other wrought states. Physical properties of the cast alloys are determined from small separately cast bars, and in this article some valuable data on the effect of thickness and heat treatment on the strength and ductility of a light, aluminum-copper alloy is presented. The author is first lieutenant, United States army air corps, McCook field, Dayton, Ohio.

Depend On Heat Treatment

Desirable physical properties of the aluminum-copper, aluminum-copper-iron-magnesium and the aluminum-copper-nickel-magnesium alloys are all primarily dependent upon the solution heat treatment which consists of soaking the material for a sufficient length of time to cause the hardening constituents (copper as the compound $CuAl_2$ and magnesium as the compound Mg_2Si) to go into solid solution. This is followed by quenching in water or other suitable cooling mediums. After this treatment a further increase in both strength and

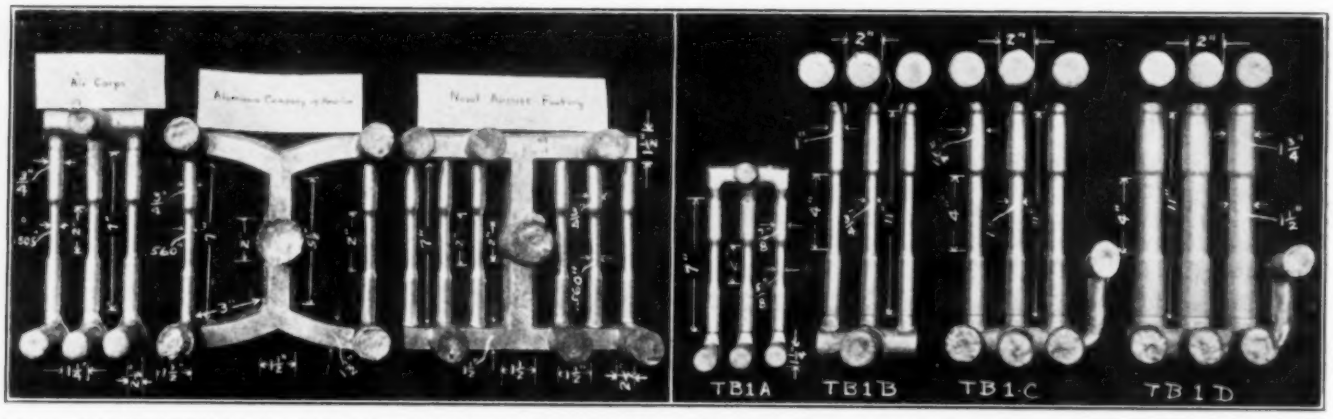


FIG. 1—THREE METHODS OF CASTING TEST BAR SPECIMENS FOR HIGH STRENGTH ALUMINUM ALLOYS. FIG. 2—DIMENSIONS AND METHODS OF GATING TEST SPECIMENS WITH GREATER SECTIONAL DIAMETERS THAN STANDARD USED IN THIS INVESTIGATION

hardness and a loss of ductility occurs after the material has stood for long periods of time at atmospheric conditions of temperature. The same changes in physical properties can be produced by reheating to a comparatively low temperature for relatively short periods of time. This treatment usually is designated as artificial ageing.

The engineer or designer is interested primarily in the actual and stable properties of the alloy in the casting or part in which it is used. The material division of the air corps has investigated the effect of thickness of section and the reheating at various periods in the temperature range from 300 to 700 degrees Fahr. on the strength of a 4 per cent copper-aluminum alloy. This alloy is manufactured to meet the following minimum physical requirements for separately-cast test specimens, such as shown in Fig. 2 (Type TB-lb specimen): Tensile strength, per square inch, 29,000 pounds, and elongation in 2 inches, 4.5 per cent. The 4 per cent copper-aluminum alloy should be distinguished from the duralumin-type casting alloys which contain magnesium; the high-copper, magnesium-iron alloy and the 4 per cent copper, 2 per cent nickel and 1.5 per cent magnesium alloy.

The alloy used for the test specimens cast for this investigation was mixed in two heats of 150 pounds each. A gas-fired, crucible-type furnace and cast iron crucible were used for this purpose. A high grade of commercial ingot, low in both iron and silicon, was utilized, and additions of iron and silicon were made by means of intermediate alloys or hardeners to give the required silicon and iron contents. The copper was introduced in the form of a 50 per cent copper—50 per cent aluminum hardener, in accordance with standard practice. Although manganese is not beneficial or desirable in this type of casting alloy, a trace is found usually in the commercial ingot. Therefore, to obtain comparable results it was added to these heats. The temperature of the metal was kept below 1550 degrees Fahr. during mixing. No flux was used and it was poured into iron molds at a temperature of approximately 1300 degrees Fahr. Chemical analyses were made from borings and the results are shown in Table II.

Test specimens shown in Fig. 2 were cast from the remelted ingots in green sand molds. In remelting, graphite crucibles were used and the temperature of the metal was not allowed to exceed 1450 degrees Fahr. in the furnace. The molds were poured at a constant temperature of 1250 degrees Fahr. which represents the optimum pouring temperature for this alloy. All temperature measurements were made with chromium-aluminum thermocouples and potentiometer. The molds were shaken out 20 minutes after the castings were poured so that a uniform rate of cooling for each size of specimen could be obtained.

Heat treatment was performed in an automatically-controlled, resistor-type electric furnace. The specimens were soaked for periods of 24 hours at 960 degrees Fahr. and then quenched in water at approximately 120 degrees Fahr. The reheating or ageing treatments were performed carefully in the same type of furnace and the periods of ageing tabulated in Tables I and III were taken from the time a thermocouple in direct contact with the specimens indicated that the required temperature had been reached. This is necessary, since aluminum absorbs heat slowly and considerable time is required for the larger test specimens to reach re-

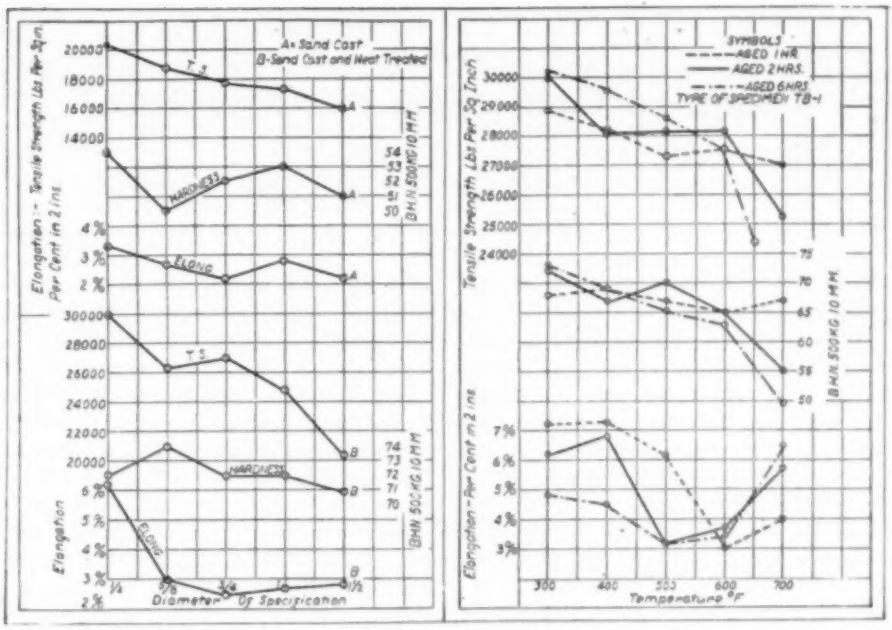


FIG. 3—EFFECT OF SECTIONAL DIAMETER ON SAND-CAST ALLOY. FIG. 4—EFFECT OF AGEING TEMPERATURES ON SAND-CAST ALLOY, HEAT TREATED 24 HOURS AT 960 DEGREES FAHR., QUENCHED IN WATER AT 120 DEGREES FAHR.

Table I

Effect of Sectional Thickness on Physical Properties

Physical Properties—Quenched 950 Degrees Fahr.; Soaking Time, 24 Hours; Aged at 300 Degrees Fahr. for Indicated Time—Melt 480

Aging Time, hr.	½-in. Dia. Type TB-1 Specimen	⅝-in. Dia. Type TB-1A Specimen	¾-in. Dia. Type TB-B Specimen	1-in. Dia. Type TB-C Specimen	1½-in. Dia. Type TB-D Specimen
2	30,070-6.2-72	26,380-3.0-74	27,050-2.5-72	24,740-2.7-72	20,390-2.8-71
4	29,160-5.8-66	27,720-2.7-72	27,825-2.1-73	26,150-2.7-71	21,020-1.8-63
6	30,150-3.7-73	28,820-2.5-76	29,670-2.2-78	26,680-2.5-73	21,830-2.7-67
8	33,060-5.0-79	30,170-2.0-76	31,220-2.5-76	26,970-2.3-76	23,060-1.5-68
10	33,300-3.5-79	29,590-2.2-77	31,990-2.2-81	27,050-2.0-76	24,220-1.5-66
15	34,030-3.2-83	29,520-2.2-76	29,580-2.0-82	27,500-1.5-78	23,470-1.7-72
20	36,150-3.0-88	30,720-1.5-83	31,330-1.5-84	28,870-1.7-80	24,300-1.5-68
30	36,180-2.7-89	32,930-0.8-89	33,270-1.8-88	29,740-0.8-84	26,010-0.8-82
40	36,940-2.0-91	33,130-1.5-88	33,960-1.5-87	30,240-1.0-84	26,300-1.2-75
50	37,040-2.1-93	32,870-1.2-86	33,520-1.5-88	29,200-1.5-81	27,050-1.2-77

NOTE: (a) 30,070-6.2-72 = Ultimate strength, lb./sq. in.—Elongation in 2 in., per cent—Brinell Hardness.
(b) Each tabulated result is the average of three tests.

Table II

Chemical Composition of Alloys Used

Melt No.	Copper	Iron	Silicon	Manganese	Aluminum
480	4.38	0.81	0.61	0.02	Difference
583	4.28	0.90	0.65	Trace	Difference

heating temperatures in excess of 500 degrees Fahr.

Physical tests were made in accordance with standard methods. All specimens were pulled without machining. The diameter for calculating the cross-sectional area was taken as the average diameter at the reduced section or gage length. The elongation was measured on the broken specimen in a gage length of 2 inches and four times the diameter. Only the readings taken on the 2-inch gage length are recorded in Table I, since the difference in the values obtained was negligible. Brinell hardness impressions were made on flats ground on the shanks or ends of the tension specimens. A load of 500 kilograms and a 10-millimeter ball applied for 30 seconds were utilized.

Dr. Zay Jeffries, in referring to aluminum casting alloys in general, has stated that castings of a larger section than 0.5-inch would have a strength of 70 to 75 per cent of the cast test bar values (*Proceedings* of the American Society for Testing Materials, 1926, Vol. II, page 346). Dix and Lyon (*Journal* of the Institute of Metals, Vol. 32, No. 2, 1924) have shown that the strength of a 4 per cent copper alloy with small amounts of magnesium, heat-treated, is about 76 per cent of the test specimen results. The latter result was obtained on specimens cut from a 1-inch section of a Liberty-12 crankcase which weighed approximately 100 pounds, including the gates and risers.

In Fig. 3 curves are shown which indicate that the thickness of section has a more pronounced effect on both the tensile strength and ductility of the heat-treated alloy than when it is in the *as cast* condition. The ultimate strength of the 1.5-inch specimen, heat-treated (quenched but not aged), was only 61 per cent of the strength obtained on the 0.5-inch specimen when subjected to the same heat treatment. The *as cast* specimen developed 80 per cent of the standard test specimen value for ultimate strength. These curves indicate that the strength is proportional to the sectional diameter, a 0.75-inch specimen developing approximately 90 per cent of the standard specimen strength in the heat-treated condition. Ductility of the heat-treated alloy is reduced rapidly with small increases in the sectional diameter, and then after further increase there is little change. There is a pronounced break in the curve corresponding to the specimens 0.75-inch in diameter, and sections above this thickness cannot be depended upon to give elongations much over 35 per cent of the standard test bar values. Reduction of the ductility of the alloy in the cast condition is less marked and there is little change in the hardness either for the heat-treated or for the cast alloy with the different sizes of test specimens.

Results of this investigation show that artificial ageing at 300 degrees Fahr. for periods of at least 15 hours is desirable in castings containing heavy sections. The reason for this is that the tensile strength of the heat-treated and aged specimens over 0.75-inch in diameter have a higher percentage of the strength obtained in the tests on the standard test bar subjected to the same treatment. From an inspection of the data tabulated in Table I and in curves shown in Fig. 5, 6, and 7, it may be seen, as pointed out previously, that the ductility is comparatively low in the heat-treated and quenched specimens whose sectional diameter is greater than 0.75-inch. Increased strength due to artificial ageing is pronounced and the percentage loss of elongation is low due to a low initial value. The ductility of this alloy in the fully aged condition, however, is superior to the higher copper-aluminum alloys and the aluminum-copper-magnesium alloys mentioned elsewhere in both light and heavy sections.

Another factor in support of the long periods of artificial ageing is the effect it has on increasing the proportional limit. It has been found that this property increases more rapidly and to a greater extent than the ultimate strength (see "Stability and Permanence of Air Corps Casting Alloys," THE FOUNDRY, Nov. 1, 1928). This property is especially important in such parts as crankcases where studs or hold-down bolts are screwed directly into the casting. Also it may be pointed out that the 4 per cent copper-aluminum alloy will age naturally over a period of two or three years, so that it is only reason-

Table III

Effect of Ageing on Physical Properties of 0.5-inch Specimens

Physical Properties—Quenched at 950 Degrees Fahr.; Soaked for 24 Hours

Ageing time, hr.	Aged at 300 degrees Fahr.			Aged at 400 degrees Fahr.			Aged at 500 degrees Fahr.			Aged at 600 degrees Fahr.			Aged at 700 degrees Fahr.		
0	28,690	7.5	63	29,570	7.0	65	27,320	6.5	64	26,940	6.2	62	26,650	6.8	63
¼							27,700	7.5	65	26,840	5.2	66	27,810	4.0	66
½				28,550	7.3	68	27,900	6.8	64	28,010	4.0	67	27,230	3.8	63
¾							27,510	6.8	65	28,400	3.2	67	26,690	4.3	63
1	28,910	7.2	68	28,220	7.3	69	27,370	6.2	67	27,510	3.0	65	27,030	4.0	63
1½				28,230	6.5	66									
2	30,070	6.2	72	28,100	6.8	67	28,120	3.2	70	28,150	3.7	65	25,250	5.7	55
3	29,160	5.8	66	28,550	5.5	68	29,700	3.0	69	27,950	3.3	64	23,190	5.0	51
4	29,740	4.8	69	28,830	4.8	67	29,170	2.8	69	27,300	3.8	62	23,340	6.0	49
5	30,130	3.7	70	29,070	4.2	68									
6	30,150	3.7	73	29,540	4.5	68	28,760	3.2	66	27,520	3.5	63	22,970	6.5	49
7	30,290	4.0	72												
8	33,060	5.0	79	30,290	4.0	74	29,570	2.8	70	25,630	3.5	61	23,650	6.5	51
10	33,300	3.5	79	31,700	2.7	72	28,700	2.8	67	25,550	3.5	59	22,160	7.2	46
15	34,030	3.2	83	32,160	2.8	74	28,010	2.5	69	24,940	4.3	56	23,320	7.5	49
20	36,250	3.0	88	31,920	2.5	76	28,380	2.5	65	24,860	4.2	55	23,530	7.7	48
30	36,180	2.7	89	31,220	2.3	73	28,000	2.5	64	23,420	4.8	50	22,740	6.5	48
40	36,940	2.0	91	30,700	2.5	72	27,560	2.5	63	22,730	5.0	48	22,140	6.0	49
50	37,040	2.1	93	30,630	2.5	70	26,080	2.8	62	22,470	5.5	49	22,840	6.7	49

NOTE: 28,690—7.5—63 = Ultimate strength, pounds per square inch—Elongation in 2 inches, per cent—brinell hardness.

able that any treatment that can be given to place it in a permanent or stable condition should be employed.

Hardening and strengthening effects of artificial ageing are dependent both upon the temperatures in the range from 200 to 500 degrees Fahr. and the time of exposure to these temperatures. It has been found as a result of heat-treating aluminum-copper-nickel and aluminum-copper-magnesium alloys that ageing at 400 degrees Fahr. for 1 hour will produce practically the same physical properties as ageing for 16 hours at 300 degrees Fahr. For the straight aluminum-copper alloy used in this investigation, it is shown that the optimum ageing temperature is about 300 degrees Fahr.; and, although ageing at 400 degrees Fahr. will cause an increase in hardness and strength and a decrease in elongation, the changes are in no way comparable to the results obtained when ageing is done at 300 degrees Fahr. for longer periods of time. This is shown in Fig. 4 and in Table I.

Effect of ageing or reheating at temperatures greater than 400 degrees Fahr. also is shown in Fig. 4 and Table I. These results are of value from a practical standpoint, since they show the stability of the alloy when exposed to temperatures greater than atmospheric for comparatively long periods of time. There are parts both in water and in air-cooled engines that are subject to elevated temperatures during operation. Therefore, these results are useful as a guide in selecting a suitable alloy for such parts. However, they do not show the strength of the alloy when tested at elevated temperatures.

R. L. Templin and C. Broglio ("Temperature Effects on Aluminum Alloys," THE FOUNDRY, Feb. 1, 1929) have shown the ultimate strength to be 18,600 pounds per square inch at 500 degrees Fahr. and less than 4000 pounds per square inch at 700 degrees Fahr. The values are considerably lower than those given for the 4 per cent copper, 2 per cent nickel and 15 per cent magnesium alloy and the high copper, magnesium-iron alloy and tested under the same conditions. The results of this investigation indicate that the properties of the alloy are somewhat less stable when subjected to elevated temperatures than either of the two alloys mentioned previously and that exposure to temperatures above 500 degrees Fahr. for any great length of time will produce physical properties that are comparable with material in the fully annealed condition. It is also apparent from the results in Table III that temperature tests made on an alloy directly after the solution treatment or temperature tests made after artificial or natural ageing would be higher than those obtained on similar specimens subject to temperatures of 500 degrees Fahr. for an appreciable length of time.

It has been shown that the strength of the heat-treated 4 per cent copper-aluminum alloy is progressively lower with increasing thickness of section. On sections 1.5-inch thick, only 65 to 75 per cent of the test bar specification value should be used in design or stress calculations. Elongation or ductility of this alloy is affected to a greater extent than the ultimate strength, and the actual elongation of sections greater than 0.5-inch are less than 50 per cent of the standard test bar values. From the standpoint of the foundryman, these results show that in casting the high-strength alloys the chills on heavy sections should be utilized wherever possible in place of risers, since in the heat-treated condition the rate of cooling has a magnified effect on the strength and ductility.

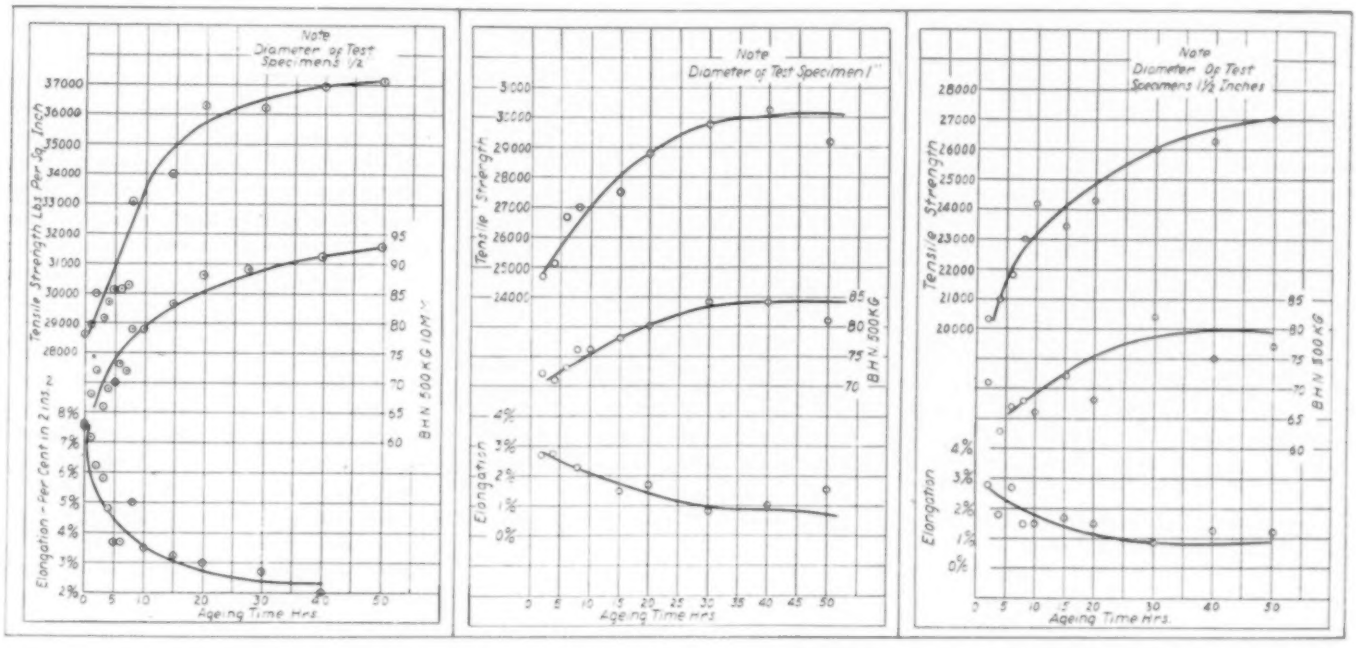


FIG. 5—EFFECT OF TIME OF AGEING AT 300 DEGREES FAHR. ON PHYSICAL PROPERTIES OF SAND-CAST ALUMINUM-COPPER ALLOY 0.5-INCH DIAMETER, HEAT TREATED FOR 24 HOURS AT 960 DEGREES FAHR. AND QUENCHED IN WATER AT 120 DEGREES FAHR. FIG. 6—SAME ON ALUMINUM-COPPER ALLOY 1-INCH DIAMETER. FIG. 7—SAME ON ALUMINUM-COPPER ALLOY 15-INCH DIAMETER

It is shown that the thickness of section has less effect on the hardness than on the strength and ductility. The desirability of ageing at 300 degrees Fahr. is shown and there is evidence as to the advisability of subjecting all castings of heavy sections to ageing periods of approximately 15 hours at 300 degrees Fahr. Stability of the physical properties of this alloy at temperatures greater than atmospheric is shown and it is concluded that continued exposures to temperatures greater than 500 degrees Fahr. will cause the heat-treated and quenched alloy to revert to the annealed condition if exposed for a sufficiently long period of time.

The accompanying tables and curves show the effect of thickness of section for various artificial ageing treatments on the physical properties of the 4 per cent copper-aluminum alloy.

Producing Steel Castings in the Modern Foundry

Part III

By Charles W. Veach

CYCLE of operation in a steel foundry is different from that of a steel mill. In the latter preparing the molds to take care of a heat is done with little labor and in a short time while in a steel foundry the product of the entire molding force is required to contain the heats as they are made ready to pour. Therefore, a definite schedule of tapping heats is essential to maintain an unbroken cycle of operation. Without regard for the number of furnaces in operation the sequence of tapping heats must be maintained if the cycle is to be uninterrupted. That is, if three furnaces are producing and it requires 6 hours from tap to tap to make a heat, a heat should be tapped every 2 hours.

Time Regulation Necessary

Importance of regulating the time of heats is recognized when consideration is given to the number and types of flasks available, and the necessity of returning the flasks to the molders after they have been poured and shaken out. Even with a surplus of flasks to keep the molders busy when a heat is delayed and the schedule of tapping broken, there is a limit to the number of molds that may be made without causing congestion on the pouring floor or in the molding department.

Scheduling becomes more important as the number of furnaces in operation decreases. If there are 5 or 6 furnaces in production, then heats will be tapped almost continually. As fast as one heat is poured and the molds removed, another will be ready to tap. Therefore, it is obvious flasks are being returned to the molding department continuously. If there are many different designs of castings being made, only a few of each will be poured in one heat so that the flasks may be returned to the molders as soon as the castings and sand are shaken out. This requires co-operation between the melting and molding departments. The number and kind of molds to be poured from a heat is determined by one who is familiar with the weights of the varioius castings and knows approximately how many pounds of metal is required to pour each mold. Here, as in all other departments of steel foundry practice, guess work will not suffice, and if practiced will prove costly. Close co-operation is essential.

Must Adjust Conditions

On one hand the head of the molding department may have his schedule upset when it becomes necessary to take out of the sand some of the heavy patterns so that rush orders of lighter work can be produced. He may turn out a greater number of molds on the lighter patterns, but they will require less metal. This slows down melting operations causing the heats to be tapped at wider intervals. If heavy work is put in to take the place of light work, the intervals of tapping will be shortened.

It is not difficult for the melter to adjust conditions of operation to meet the first mentioned condition, but it may or may not be difficult for him to meet the latter condition. If he already has been driving his furnaces to their limit of speed, he cannot make the heats shorter without injury to the furnace lining. Also, at-

Makes the Bottom

MAKING the bottom in an open-hearth furnace is an operation that must be performed carefully if the best results are to be obtained. Some operators use imported magnesite for making the basic bottom while others find that domestic magnesite works as well. Generally dolomite is used for repairs except in deep holes which first are filled with magnesite. In this article the author describes the making of a bottom composed of synthetic dolomite.

FIG. 6—TAPPING SIDE OF THE FURNACE. THE LADLE IS PLACED IN A PIT IN FRONT OF THE SPOUT. FIG. 7—IN THIS FOUNDRY THE POURING FLOOR IS IN FRONT OF THE FURNACES

tempting to speed up the melting operation may result in sacrificing quality. He may increase the size of the heats substantially without extending the time required to make them. This statement may seem a paradox yet is true as will be shown in a later article.

Conditions over which the head of the melting department has no control may arise to upset his plans. A breakdown of some of the equipment furnishing the charges may occur. The charging machine may get out of order causing delay. Trouble with the oil or oil pump, where this fuel is used, or trouble with the producers when producer gas is the fuel, may cause temporary delay upsetting the schedule planned by the melter. However, co-operation between the operating and maintenance departments will minimize delays from equipment. With this phase of the organization arranged, it only remains for the melter to make the most of the equipment directly under his own control and be prepared for any emergencies that may occur.

Many Variables Present

Objections to making out a schedule at the beginning of the week for the whole week may be based on the fact that a furnace is not like a machine. Each heat charged is a separate problem. Too many variables are present to allow successive heats to be uniform. One heat will melt sooner than another. Some heats will melt with higher carbon than others, requiring longer time for working than those melting with lower carbon. Holes may occur one time and not appear another. The slag line may be cut to a greater extent on one heat than it is on another. Other things may happen to delay the heats and ruin the schedule.

However, all of these things may be controlled. The author pointed out the value of control in the July 15, 1920 issue of the *Iron Trade Review*. In that article several factors of interest to basic open-hearth operators were discussed, such as, care in selecting the charge; a sharp working furnace; means of control of the flame; a good bottom, and proper supervision of the work by competent melters. However, it is doubtful if anyone had at that time worked out any systematic control of operations which would enable them to schedule their time of tapping heats with assurance that the schedule would be met over a considerable period.

In this discussion one furnace will be considered in operation. Those having two, three, or more furnaces in operation may apply the principles with less difficulty than when only one unit is producing because more help is available to make up bottoms after heats are tapped. If holes occur when only one furnace is running it is difficult to get the holes properly cleaned out because of the small number of men available, and the trouble may become cumulative. Therefore, it is of vital importance that the bottom be prepared properly over the week-end for the subsequent week's run.

Since the discovery and adaptation of the open-hearth process intermittent conditions due to bottom trouble, have been tolerated and it usually has been supposed that bottom trouble was a concomitant condition of making steel by that process. Here as elsewhere, an ounce of prevention is worth pounds of cure. It follows that good bottoms are the result of properly choosing the materials of which they are made, making the bottoms, and maintaining them during production.

Making bottoms as well as the material best suited for their construction has been given considerable attention by open-hearth superintendents at meetings of technical bodies during the past two years. Open-hearth men are about equally divided between those who prefer imported magnesite for bottoms and those who believe that domestic magnesite answers as well. Only a few operators so far have ventured to use dolomite for putting in new bottoms. However, most bottoms are being repaired with dolomite, except that bad holes are repaired with magnesite in plants where this material is used in the original bottom.

Until recently the author believed that magnesite was the only material available with which a basic bottom could be made that would give lasting service, but he advocated the use of domestic magnesite, having found it fully as efficient as the imported, and much less expensive. During the past few months the author has been convinced that magnesite may be dispensed with entirely and a substitute used. The substitute is a synthetic dolomite, of which there are many, but the particular product referred to is a clinker made by mixing dolomitic stones obtained from two mines widely located, and having peculiar characteristics of their own. These attributes disqualify the mineral when used alone for refractory purposes, for one is too high in silica content and the other contains too much of another element. However, when properly blended the resulting clinker has a minimum of 85 per cent basic element, and averages under 15 per cent of fluxing element. The formula for the synthetic dolomite was developed by Dr. M. E. Holmes, at one time connected with the bureau of mines, Washington, and now director of ceramic engineering at the school of mines, Rolla, Mo.

FIG. 8—POURING FLOOR IN ANOTHER FOUNDRY WITH THE DRYING OVENS AT THE LEFT

A brief resume of the procedure in making a synthetic dolomite bottom may be of interest. The temperature of the furnace was raised to a heat high enough to melt slag readily, and sufficient slag was added to close all of the interstices between bricks in the bottom of the furnace. After all cracks had been closed so that the surface of the bricks appeared smooth synthetic dolomite was added, scattering it over surface in thin layers. The time required to slag in the brick lining was 4 hours. After this thin layers of a mixture of 75 per cent synthetic dolomite and 25 per cent slag was scattered over the bottom. This mix-

ture was continued for a period of 12 hours. Additions were made at intervals of 2 hours, the furnace was kept at the critical temperature of the silica brick. The material was scattered over the corbled portion of the lining, and except at the ends where the bricks rise abruptly, the surface was covered after 36 hours.

After the first 24 hours the mixture was 4 synthetic dolomite to 1 slag. However, this mixture was not used on the flat of the bottom after the third day because the clinker appeared too soft. An 80-20 mixture

FIG. 9—VIEW OF A FOUNDRY MAKING MISCELLANEOUS STEEL CASTINGS AND ROLLS

was used in building up the banks, and for this purpose no change in the mixture was made.

As soon as it was apparent that the flat portion of the bottom was too rich in slag, synthetic dolomite from the pile was used without mixing slag with it. By taking tests frequently it was found advisable to scatter slag thinly over the bottom, care being taken not to create a sloppy condition. In other words, there was added only enough slag to insure solidity in the clinker, and this was determined by the test specimens taken and examined after cooling. In these examinations dependence was not placed solely on the unaided eyesight, but a high powered microscope was used in making a study of the tests. Its use is both instructive and interesting.

Only 20 tons of material was used to make this bottom. When it is considered that the furnace will hold 35 tons nicely it is apparent that the bottom is thin, particularly in the center and at the slag line. Although nearly 200 heats have been tapped, no bottom trouble has occurred. All the maintenance cost entailed so far has been the washing out and coating the surface at the week-end.

Bottom upkeep consists of repairing the bottom wherever holes occur or scorification takes place. Small holes in the flat of the bottom may be disregarded, for usually what is taken for a hole is only metal and slag trapped by lime deposit which may clean up on a subsequent heat. However, holes appearing in the slag line should be examined carefully, and after all metal and slag is removed the hole filled under the maximum operating heat. A hole in the slag line must be serious before it causes delay, for once it is cleaned out and filled with new material all that is required for safety is to slag it over so pig metal will not be taken up by the new material.

A good system of preparing bottoms for the coating of new material is to have a supply of crushed slag on hand, and for the operators to shovel this slag in where it will do the most work in loosening and liquifying the accumulation of lime on the bottom and banks. After a bath of slag has been accumulated, moving a rabble back and forth with all the force that can be applied soon will wash down any lumps from above the slag bath, and reduce them to liquid form. When the bath has been thinned properly it is tapped out, the hole closed up, and one or two more slag washes run before any material is added, depending, of course, on the appearance of the bottom.

The final step is to add the new material in much the same way it is added when a new bottom is being made, taking pains to sinter it in place. Then both the banks and bottom are slagged in before closing down over the week-end. Also, each week-end the tap hole should be cleaned out thoroughly and piped if necessary.

Over the week-end the bridge walls should be inspected and repaired where required. The banks should be built up as high above the slag line as possible. This is done with chrome ore and is a feature of furnace maintenance which affords large economies.

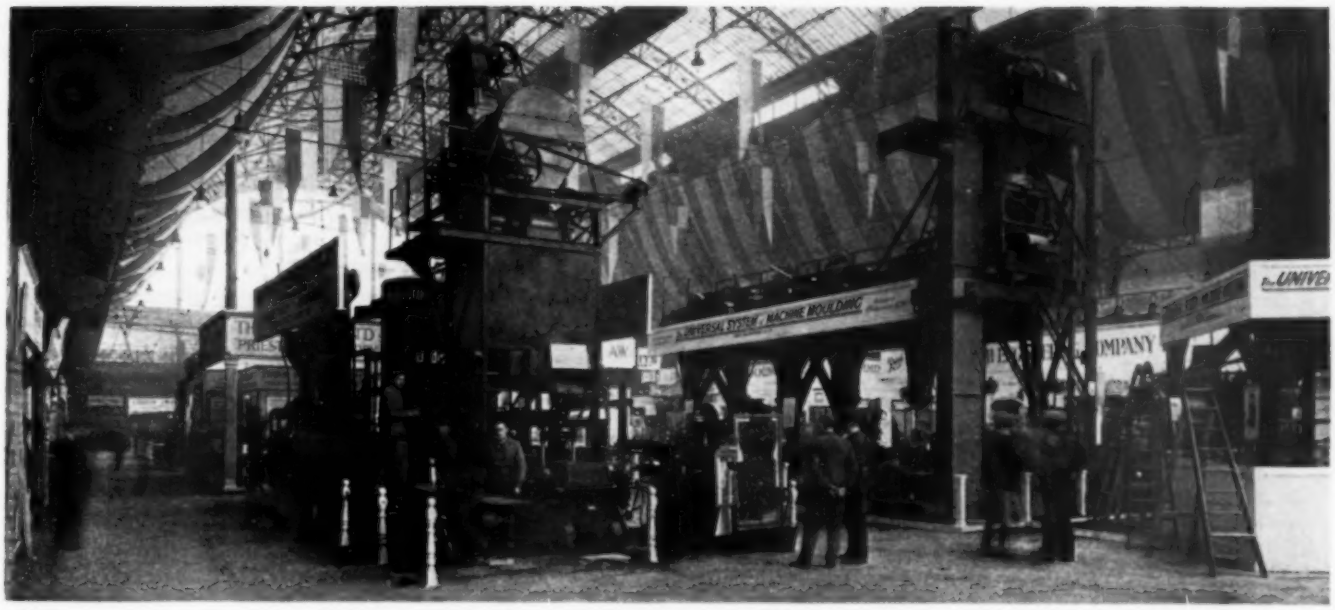
From about 125 to 165 heats on the front wall and the back wall is considered normal practice with many steel plants. Steel foundries do a little better as a rule, but many steel foundries find it necessary to renew the front and back walls when about 200 heats have been made. This means that on Saturday the furnace lining will be about 3000 degrees Fahr. and cooled down as rapidly as possible so that the masons can work on the walls either Saturday afternoon and night, or on Sunday. This rapid cooling down of the structure is not good for that part of it which needs no repair, and particularly is it not good for the bottom.

Each time a furnace is cooled down to make a hot patch a tremendous amount of stored heat is lost, not only in the furnace proper but in the flues and checkers as well. Before production begins again after a week-end repair considerable fuel is consumed in bringing the furnace back to temperature. It is here that the intelligent use of a properly prepared chrome ore pays large dividends. For by it at least one week-end repair and possibly two may be avoided during each furnace campaign. The author believes that a furnace campaign should consist of 500 heats, in foundry practice and that only one hot repair should be necessary during the time that it requires to make that number of heats.

French Foundrymen Will Meet in Paris

The annual convention of the Association Technique de Fonderie de Paris will be held at the Ecole des Arts et Metiers, Paris, Oct. 25 and 26. H. Bornstein, chief metallurgist, Deere & Co., Moline, Ill., will present the exchange paper of the American Foundrymen's association. The subject will be "Agricultural Implement Castings." The exchange paper of the Institute of British Foundrymen will be by H. Turner, University of Birmingham, who will contribute a review of the alloys now being cast in Great Britain, with special reference to nonferrous alloys.

American Engineering Co., Philadelphia, has removed the New York offices of its stoker division from 100 Broadway to the American Radiator building, 40 West Fortieth street.



Molding Machines and Sand Handling Equipment Attracted Considerable Attention from the Exhibition Visitors

International Exhibition Shows *Foundry Progress*

OPINION was unanimous at the opening of the International Foundry Trades' exhibition at the Royal Agricultural Hall, London, on June 5 that the exhibition was more comprehensive and representative of the foundry industry than any previously held in Great Britain. Over 100 exhibits, including representative firms in Great Britain, Belgium, France, Germany and the United States, covered the floor of the Royal Agricultural Hall. Every branch of the foundry industry was represented.

The exhibition was opened formally by Sir James Fortescue Flannery, chairman of Flannery Baggallay & Johnson, Ltd., W. & T. Avery, Ltd., and Callender's Cable and Construction Co., Ltd. He laid stress on the growing use of labor-saving machinery, on the benefits derived from the combination of theory and practice in all branches of the industry, and on the inter-communication of nations in the domains of science and commerce. Following the opening of the exhibition, a luncheon was served the exhibitors by F. W. Bridges & Sons, Ltd., the organizers of the exhibition, at which H. Winterton, chairman of the Foundry Trades' Equipment and Supplies Association, Ltd., presided as chairman.

One of the features of the exhibition was the technical exhibit, which illustrated some of the scientific and research work being carried out in Great Britain in connection with foundry problems. To this end the research associations, the National physical laboratory, the universities and their research laboratories contributed material. A display of photographs, sample castings and graphs also was contributed by the Ecole Superieure de Fonderie of France, Die Giesserei Institute of Germany, the American Foundrymen's association, and Association Technique de Fonderie of Belgium.

Displays Cupolas

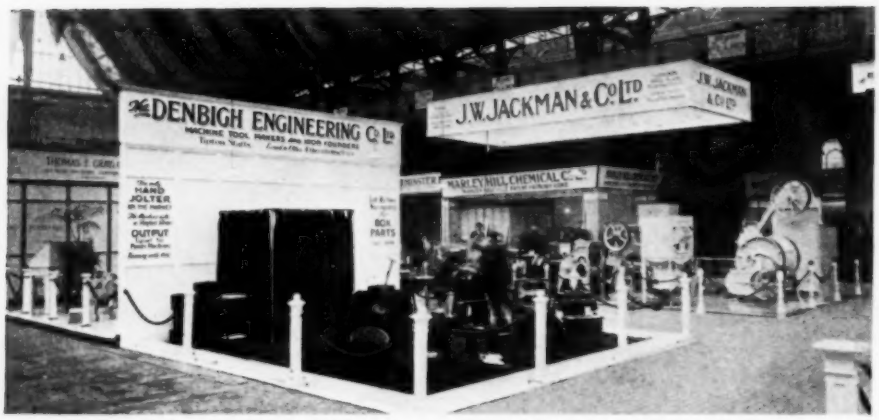
The Constructional Engineering Co. Ltd., Titan works, Birmingham, exhibited a cupola constructed under the Poumay system. Under this system, it is claimed that coke economies varying from 20 to 60 per cent are effected. At the same stand was a bottom section of a standard cupola with special tuyeres independently adjustable from the outside air belt, and with an inspection door to each tuyere. The exhibit included a spark arrester, and a cupolette, with a capacity of ½-ton per hour. Other items manufactured by the company also were shown.

The stand of Reavell & Co. Ltd., Ipswich, included a number of compressors, air-cooled and water-cooled, a pattern hoist with a lifting capacity of 2000 pounds. These hoists occupy either a horizontal or vertical position. Pneumatic tools also were displayed.

Watson Ltd., Sheffield, showed an electric rotating furnace for melting nonferrous metal. Heat up to 1500 degrees Cent., it is claimed is obtained from two or more electrodes. These furnaces are made in any capacity desired between 200 and 500 pounds.

J. W. Jackman & Co. Ltd., Manchester and London, showed a light roll self-delivering sand mill and mixer in which the roll is of special conical shape to suit the slope of the pan. The pressure on the roll may be varied by an adjustable spring attachment. Among other exhibits on the stand were a portable motor-driven sand disintegrator and thrower, a separator of the revolving screen type and a portable electric riddle for screening sand.

This company also showed several types of molding machines made by the Osborn Mfg. Co., Cleveland, including a jolting machine for general work, two press rollover jolting machines in which the molds are pressed after jolting, and a jolt strip portable



Hand-jolt Machines, Flasks and Sand Mixing Machines Were Displayed

molding machine. Other molding machines at this stand included a hand-operated molding machine and a down-draw hand-operated molding machine made by J. W. Jackson & Co. Ltd., in which the sides are adjustable, so that flasks of different widths may be accommodated. A core jolting machine, made by the Tabor Mfg. Co., Philadelphia was operated pneumatically at 80 pounds pressure. Sand blast equipment at that stand included cleaning cabinets and sand blast tumbling barrel.

Displays Mold Dryer

Pittevil & Co., of Brussels and London, main distributors for Societe Anonyme Silica of Nimy-lez-Mons, Ketin et Thirtiart and Ivan Lamoureux of Liege, Belgium, showed mold dryer, with a special device to prevent the temperature from exceeding 380 degrees Cent. Heat from a coke fire is conducted to the mold through pipes. A 3-ton ladle was shown at the same booth. All sizes from ½ to 25 tons, are equipped with special tilting gear independent of any difference of expansion between the ladle belt and the top cross member. A sand-preparing plant, and pan-mill and disintegrator, also was displayed. On the stand also were displayed samples of sand from the Societe Anonyme Silica's quarries.

The booth of the Universal System of Machine Moulding & Machinery Co. Ltd., was fitted up, with a sand conveyor, and five hoppers which supplied sand to five different types molding machines made by Bonvillain et Ronceray, Paris, France. These machines were served by mold conveyors of the roller type, and a complete representation of a foundry in operation was given. The machines shown included one which rams the top and bottom parts of the mold simultaneously, withdraws the pattern-plate, closes the boxes and eventually pushes the mold completely through the box. Another machine for deeper work, operated in conjunction with the rollover machine. A machine for making large flat stove plate also was on the stand. All these machines were operated by hydraulic pressure. A new type for snap flasks, just put on the market operates by compressed air. The firm also exhibited the latest type all-steel pulley blocks.

Pneulec, Ltd., Smethwick, near Birmingham, manufacturers of foundry equipment, demonstrated sand mixing machines and an electric swing grinder. In the grinder the shaft runs on ball bearings and the wheel revolves at right angles to the motor shaft. That firm recently acquired the manufacturing and selling rights in Great Britain for sand-handling and conditioning plant of C. O. Barlett & Snow Co., Cleveland.

Badische Maschinenfabrik und Eisengiesserei, Durlach, Germany, represented in Great Britain by the firm of John A. Smeeton, Ltd., London, demonstrated a compressed air sand throwing machine. This machine is fitted with a sand screening and elevating unit which lifts the sand from the floor level and passes it over a magnetic separator, from whence it goes into the main receiver. The sand then passes down the receiver under control into a small receptacle and comes into contact with the compressed air stream, which forces the sand along a specially-designed hose, to a nozzle through which the sand is blown into the mold.

The same firm displayed a sand-preparing plant and three different types of shockless jolt molding machines; also a portable machine for making cores.

Sterling Foundry Specialties, Ltd., British subsidiary of the Sterling Wheelbarrow Co. Milwaukee, showed a comprehensive selection of rolled steel flasks and wheelbarrows.

Viozone, Ltd., London, exhibited a new pyrometer, calibrated with a scale of degrees Centigrade. The center of the frame consists of shaded glass graduated from clear to opaque. A slide with a hole moves along the frame and is used to sight the heated material. This slide is pushed until the glow no longer can be seen, through the glass when the heat temperature is found registered on the scale.

Feature Many Furnaces

The Pneumatic Engineering Appliances Co. Ltd., London, with works at Manchester, showed a rollover molding machine, and also a new direct-draw machine, both operated by compressed air; also a variety of pneumatic tools.

Sir W. G. Armstrong, Whitworth & Co. Ltd., London, exhibited a number of oil-fired central axis tilting furnaces, one of 500 pounds capacity for melting aluminum, the other of from 500 to 1000 pounds capacity for melting ferrous and nonferrous metals, a pressure casting machine for zinc base alloys, a white metal melting and refining furnace, a pit type lift-out crucible furnace, oil-fired, and an aluminum ladling furnace iron pot type. A variety of pneumatic tools, and samples of refined pig iron also were shown.

August's Muffle Furnaces, Ltd.,

Operating Exhibits Occupied Many of the Booths

Halifax, showed a laboratory-size sand mixer of the type made by the National Engineering Co., Chicago. A full-size mixer also was shown. On the same stand was a portable mold drier using ordinary gas coke as fuel, and a portable drawer type core stove, which can be fired by coke, gas, oil, or electricity.

Black & Decker, Ltd., Slough, England, displayed a comprehensive line of electric tools, including portable drills, tappers, sanders, screwdrivers, grinders, and an electric swing frame grinder for use with high speed grinding wheels, up to 10,000 surface feet per minute. W. & C. Pantin, London, manufacturers of conveyors, showed a section of gravity roller conveyor suitable for handling molds, castings, etc.

Coleman Foundry Equipment Co., Ltd., London, exhibited a variety of foundry equipment, including a number of molding machines. A jar ram open-end power squeeze molding machine, has a lifting capacity of about 6000 pounds. One jar ram stripping plate machine and one jar ram roll-over draw molding machine were made by the Milwaukee Foundry Equipment Co., Milwaukee. An interesting machine made oblong and round runner bushes and riser cups. The stand also included sand-throwing and sand-mixing machines, a set of sand-testing machines suitable for the laboratory, and a core-making machine for both round and square cores.

The Britannia Foundry Co., Ltd., Coventry, had a display of molding machines including a jar ram molding machine driven by compressed air with a lifting capacity of 1200 pounds. It also showed a rollover jar ram molding machine, in which the molds are withdrawn by a ball-bearing trolley on extension lines. Other machines also were displayed by the firm.

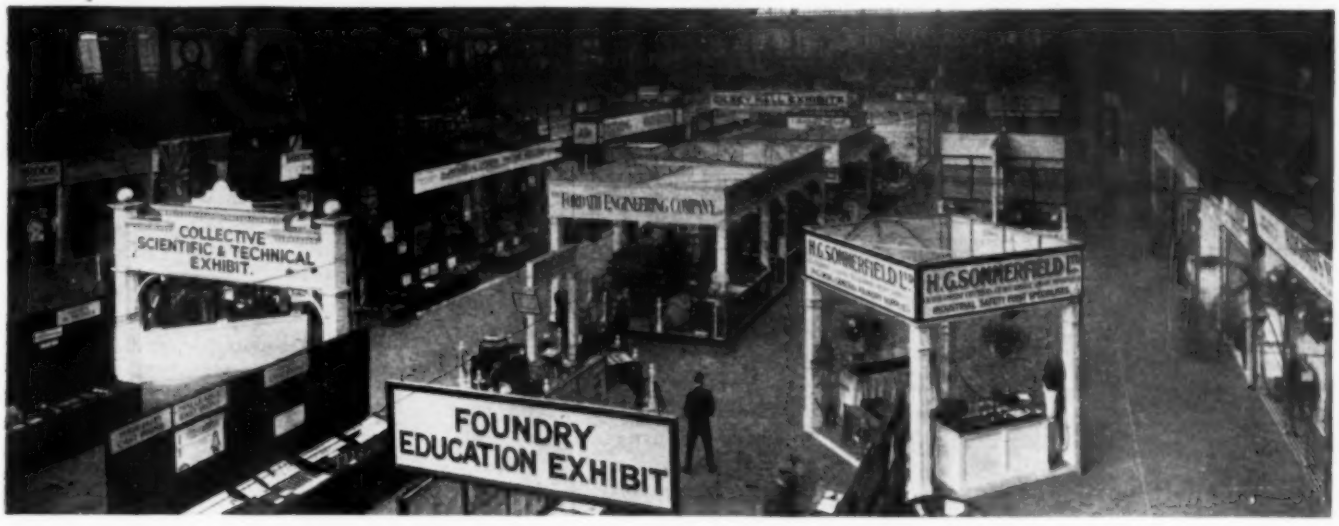
The Electric Steel Castings Co., Ltd., Sheffield, exhibited a number of molding machines made by Wm. H. Nicholls Co., Inc., Richmond Hill, Long Island, N. Y. That company also displayed a number of woodworking machines manufactured by Rauschenbach Engineering Works, Ltd., Schaffhausen, Switzerland, and grinding wheels manufactured by the Swiss Grinding Wheel Works, Ltd., Winterthur, Switzerland.

The Denbigh Engineering Co., Ltd., Horseley Heath, Tipton, showed hand jar ram molding machines, straight draw and rollover types; also cast iron parts for flasks with special system of registration.

Gustav Zimmermann Engineering Works, Dusseldorf, Germany, exhibited a shockless jolt squeeze stripping plate cope molding machine and a jolt squeeze rollover molding machine for molding drags; also a portable jolt squeeze molding machine and a machine for vibrating the mold from both sides, a core-blowing machine for complicated cores and a core-vibrating machine for simple cores.

A range of molding machines made by the Tabor Mfg. Co., Philadelphia, and shown by Macnab & Co., London, included a 22-inch portable plain jarring machine, a 14 x 16-inch split pattern machine, a 13-inch jar squeezing column-type machine, a 20-inch plain jar stripping machine, a 10-inch plain jar squeezing, yoke type, stationary machine; also a portable machine of the same type and a core-making machine. John MacDonald & Son, Nitshill, near Glasgow, exhibited a new model jar and pattern drawing machine operated by compressed air. It accommodates flasks from a minimum of 12 x 14 inches to a maximum of 16 x 18 inches, and is fitted with a control valve, pilot and jarring valve, and a 1-inch vibrator for pattern draw.

Macnab & Co., London, showed a selection of the sand plant machinery manufactured by E. Gernelle-Danloy, Rouen, France. In a rubbing, crushing and mixing mill provided with special profile patented mullers and centrifugal aerator, the fully-treated sand passes to the automatic discharge, runs down an incline directly into the centrifugal aerator which throws it in any direction required. A mixing and crushing machine with stationary mixing container for oil-core sand or for mixing sand with oil, a throwing aerator of a new type, and models of sandblast cleaning cabinets also were on display.



A General View of the International Foundry Trades' Exhibition which Was Conducted in London, June 5 to 15

Rapid Magnetting Machine Co. Ltd., Birmingham, showed a 3 to 4-ton per hour sand screening and separating plant, and another plant working 1 to 2 tons per hour. The sand, after being shoveled into the boot of the elevator, is carried up and deposited into a jig shaken tray, where it is sieved, and from thence it passes over the face of a high intensity drum, where the iron is carried round to the back bottom position, and the sand falls in the front by gravity. The firm also displayed a variety of separators and magnetic chutes; also a 20-inch diameter magnetic clutch.

Midland Sand Blast & Foundry Supplies Co. Ltd., Warwick, displayed tumbling barrel sandblast machines, a rotary table sandblast machine, and a molding sand sieving and mixing machine consisting essentially of a shaking sieve, a bladed mixing drum, a mixing chamber, and the necessary gearing and electric motor. The sand is discharged approximately 10 feet from the side of the machine.

T. Fearnley Allen & Son, British and colonial agents for Alfred Gutmann, Altona, Hamburg, Germany, showed British and German sandblast

apparatus of various types and sizes.

T. E. Salter Ltd., Tipton, displayed cupola fans and motor fan sets; also emery grinders with self-contained dust-collecting sets. The Selson Engineering Co. Ltd., London, exhibited machines specially designed for the foundry, including a friction saw and double-drive grinding machine in operation, also a selection of grinding wheels.

R. W. McIlvaine Co., Chicago, represented by Sydney G. Evans, London, exhibited a meter for determining the moisture content of heap or floor sand. Photographs of conveying equipment installations at prominent foundries in the United States also were on display.

The Bureau of Information on Nickel Ltd., London, illustrated various applications of nickel in ferrous and nonferrous castings.

The Carborundum Co. Ltd., Trafford Park, Manchester, displayed a range of carborundum refractories, bricks, tiles, special shapes, tubes and muffles, made up in the form of a furnace; also carborundum crucibles designed for use in the nonferrous metal melting industry, enameling muffles, hearth tiles, refractory cements and firesand.

Show Foundry Accessories

Beecroft and Partners Ltd., Sheffield, had a stand divided into two sections, one drawing attention to their services as analysts and consultant metallurgists, the other displaying a number of different grades of core oils and compounds, foundry fluxes, parting powders, plumbagos and mineral blackings. Thomas Wilkinson & Co. Ltd., Middlesbrough, exhibited blacking and other foundry facings and requisities.

William Cumming & Co. Ltd., Glasgow, showed refractory facings, specimen samples of the bulk raw material from which coal-dust and plumbago are made, and specimen samples of various foundry furnishings, such as chaplets, riddles, etc.

General Refractories Ltd., Sheffield, showed cupola and foundry refractories, samples of molding sands, core sand, core binders, mixing sands, parting sands, molders' paints, and furnace building, lining and repairing refractories. F. W. Berk & Co. Ltd., London, showed samples of special refractory material designed for the desulphurization of cupola metal with soda ash. A 2-ton ladle lined with this material showed the condition of the ladle after actual use in a foundry.

Wadkin & Co., Leicester, exhibited a semiautomatic wood milling machine of the type exhibited at the International Foundry exhibition at Detroit in 1926 and now is sold in the United States by the Oliver Machinery Co., Grand Rapids, Mich.

H. G. Sommerfield Ltd., London, displayed a variety of safety goggles, helmets and respirators, asbestos protective aprons, leggings and spats, and samples of pig iron, foundry coke and refractory material. Samples of raw materials, including foundry coke, pig iron, molding sand and refractories were displayed by Thos. W. Ward Ltd., Sheffield; David Colville & Sons Ltd., Glasgow; British Pigirons Ltd., London; Bradley & Foster Ltd., Darlaston; Powell Duffryn Steam Coal Co. Ltd., London; Lilleshall Co. Ltd., near Shifnal, Shropshire; Anglo-Belgian Refractories, Birmingham; Consett Iron Co. Ltd., Durham, and J. B. Corrie & Co. Ltd., London.

Blackfriars Foundry Requisite Co. Ltd., London, showed various grades of coal-dust and blackings, special waterproof parting powder, corebinders, plumbagos; also foundry furnishings, shovels, sieves, etc. That company also exhibited steel flasks made by J. W. Sadler & Co. Ltd., Bradford. All these flasks are drilled to jig, thus ensuring interchangeability, and they also are machined on face and back.

Thos. E. Gray & Co. Ltd., London, showed a practical demonstration of the installation of a siliceous rammed lining in a cupola. British Perlit Licenses association, London, displayed typical castings made by the Lanz process, also data on their properties and results.

The Atlas Preservative Co. Ltd., London, showed photographs of different types of structures preserved with their special brand of iron and steel paint. Thomas & Bishop Ltd., London, exhibited jointing material, lubricating grease, leather and textile belting, and compounds for treating the surface of belts.

E. Leitz, London, displayed metallurgical microscopes and various optical apparatus used in foundry laboratories, including a large metallographic microscope and camera. Grant & West Ltd., London, exhibited jointing material, plastic metallic packing, aluminum solder and other compounds. The Mastabar Belt Fastener Co., Manchester, exhibited a belt fastener. E. A. Herbert & Co. (Birmingham) Ltd., Birmingham, showed a variety of alloys used in all branches of metallurgy and the various foundry industries, these consisting principally of deoxidizers, densifiers, degasifiers, hardeners, rich alloys, fluidizers and stabilizers. Allen-Liversidge Ltd., London, exhibited its acetylene welding and cutting and their electric welding equipment.

British Refractories Companies Merge

General Refractories Co. Ltd., Sheffield, England, with works at Sheffield, Wolsingham, and King's Lynn; Midland Refractories Co. Ltd., Ambergate; Thos. Brooke & Sons Ltd., Deepcar; Guiseley Silica Co. Ltd., with quarries in North Wales, etc., and the Worksop Brick Co. Ltd., Worksop, Nottinghamshire, have been merged under the title of General Refractories Ltd., Sheffield, England, with a capital of $750,000.

Ambergate Colliery Co. Ltd., near Derby; Craighouse Quarry Co. Ltd., Galston, Scotland; Britannic Refractories Co. Ltd., Durham; and Coolee Ltd., Bramcote, Nottinghamshire, will be controlled as subsidiaries by the merger, which also will hold a half interest in United Sands Ltd., Sheffield, and a substantial portion of the capital of the Buxton Quarry Co. Ltd.

Frank Russell is chairman and managing director of the combine. Mr. Russell visited the United States with the European foundrymen in 1926. R. A. Kirkby and H. Morgan will be associated with Mr. Russell on the board and the secretary will be W. A. Cutts. The company's registered office is at Wicker Arches, Sheffield.

To Meet in Dusseldorf

The annual autumn meeting of the British Institute of Metals will take place in Dusseldorf, Germany, Sept. 9 to 12 by invitation of the Verein Deutscher Ingenieure and the Deutsche Gesselschaft fuer Metallkunde.

In the afternoon of Sept. 9, the eighth annual autumn lecture will be delivered by Dr. A. G. C. Gwyer on "Aluminum and its Alloys." The morning of Sept. 10, will be occupied by the reading and discussion of papers and the afternoon will be devoted to plant visitations. In the evening the city of Dusseldorf will entertain members and their ladies.

On the morning of Sept. 11, further papers will be presented for discussion, and the business meetings will be brought to a conclusion. The afternoon will be devoted to visits to manufacturing plants. The evening's entertainment will consist of a cabaret and dance in the Rheingoldsaal. An all-day trip will be arranged to Essen to visit the works of Friedrich Krupp on Sept. 12.

G. H. Brinkmeyer has been appointed manager of the St. Louis office of the Pennsylvania Lubricating Co., Pittsburgh. The new office is located in the Chemical building, St. Louis.

Foundry Party Tours England and Scotland

Foundrymen From Many Countries Are Entertained Royally by Local Branches of I. B. F. During Inspection Trip Through Industrial Centers

FREEHANDED British hospitality met the overseas delegates at every point in their journey northward through the midlands, the border country and into Scotland. The first day out of London, with a train journey to Leamington, was devoted to the points of historical interest through Warwickshire, Stratford-on-Avon, Stokes-Poges and terminating in the early evening in Birmingham where members of the Birmingham branch of the I.B.F. with their ladies waited to receive the party of more than 60 American, German, Italian, Polish and Czecho-Slovakian travelers.

A visit to the plant of W. & T. Avery Ltd., Birmingham, during the morning of May 28 was followed by a reception and luncheon at the council house, the municipal government headquarters. The Lord Mayor of Birmingham, Alderman W. Byng Kenrick, and his lady tendered this courtesy. In a short address, the lord mayor welcomed the delegates, reminding them of the importance of the foundry industry, basic and invaluable, always emerging unscathed from the encroachment of competing metal products. In a brief response, S. Wells Utley, past president of the American Foundrymen's association acknowledged the courtesy of the Birmingham group.

In the afternoon, the ladies were given an extended sightseeing trip through Coventry and surrounding country, while the men of the party visited the up-to-date foundries of Sterling Metals Ltd., Coventry, where sand and die cast aluminum motor and airplane castings, gray iron and brass castings are made by modern methods. In the evening a dinner was given the entire party by the members of the local branch of the Institute of British Foundrymen at which the Mayor of Coventry, A. J. Makepeace delivered an address of welcome. A. Harley, Coventry, spoke of the historic associations of the district, outlined the industrial accomplishments of Coventry through the ages and commended the occasion as a step toward the ideal of universal peace, based upon better acquaintance between industrialists promoted by such tours as that then in progress.

H. Cole Estep, Penton Publishing Co., Cleveland, chairman of the committee on international relations, commented on the examples of high quality castings production on a mass basis which the traveling foundrymen had encountered in Birmingham and Coventry. He dwelt on the economic ideal of American manufacture, which has found low unit costs consistent with quality and high wages.

Proceeding to Derby by train, the party visited the plants of Rolls-Royce Ltd., Combustion Engineering Co. Ltd., and Ley's Malleable Co. Ltd. during the day. At all of these establishments foundry practice similar in many respects to that familiar to the Americans was encountered.

A luncheon was tendered jointly by

Visiting Foundrymen Listening To a Word of Welcome As They Sailed Down the Clyde

Rain Came Down Every Now and Then, Even When the Party Was Entering Scotland

the three Derby firms mentioned at which the mayor spoke of Derby's part in the advancement of the castings art. In the early history of the country Derby made more than 25 per cent of the total castings produced in England. He spoke of the growth of the Rolls-Royce organization from a firm employing 500 men in 1908 to one which today has more than 4500 on its payroll. The precision methods employed may be deduced from the fact that the output of the factory is 20 automobiles and 7 airplane motors per week. All three of the firms were said to have American affiliation and to be in close contact with the advance of American factory methods. President S. T. Johnston of the American Foundrymen's association acknowledged the hospitality of the city and industries of Derby.

Arrive at Matlock

After a brief journey, the party of overseas foundrymen arrived at Matlock, where a dinner was tendered by the East Midlands branch of the Institute of British Foundrymen. H. Pemberton, manager, of the foundry of the London, Midland and Scotland railway, presided. S. H. Russell, S. Russell & Sons, Leicester, president of the Institute of British Foundrymen in a toast to the visitors spoke of the importance of the district covering Derby, Nottingham and Leicester in castings production. Derby alone has 29 foundries. He emphasized the importance of the international contact on industrial matters, having as an important corollary universal peace. S. T. Johnston, president of the American Foundrymen's association responded.

Fred Erb, vice president of the American Foundrymen's association, in a brief address expressed the gratitude of the guests for the hospitalities accorded them. E. J. Fox, managing director, Stanton Iron Works Co. Ltd., Nottingham, lauded the work of the secretary of the East Midlands branch who has served for the past 14 years and invited the overseas visitors to his works on the following day. Pavel Bacher, Czecho-Slovakian representative, expressed the appreciation of the continental members for the reception.

Visit Foundries

Starting early in the morning the men of the party spent the greater part of Thursday, May 30, at the Stanton works, where they inspected blast furnaces, a complete and highly efficient plant for making centrifugal cast iron pipe and miscellaneous castings including tunnel segments for the new tunnel under the Mersey at Liverpool. The company employs over 14,000 men at its various plants, and produces pig iron for sale as well as for its own extensive requirements. A total of 1500 tons of centrifugal pipe alone is an important output. A luncheon was given at the works at which Mr. Fox, Sir Henry Fowler, director of the London, Midland and Scotland railway; S. T. Johnston and J. T. Mackenzie, American Cast Iron Pipe Co., Birmingham, spoke.

On arrival in Manchester, Thursday evening, a group of foundrymen and their ladies, representing the Lancashire branch, met the party at the train and accompanied them to their hotel. The committee was headed by E. Longdon, president of the local group.

The overseas foundrymen were entertained during the entire day and evening of Friday, May 31, by the Lancashire branch of the Institute of British Foundrymen headed by its president, E. Longdon and vice president, R. W. Stubbs. During the morning the men divided into groups and visited the plants of Crossley Brothers, Ltd., oil and diesel engine builders, Platt Brothers, Ltd., textile machinery makers or the Farrington Steel Foundry, Leyland. In the afternoon the parties combined to visit the extensive works of Metropolitan-Vickers Electrical Co. Ltd.

At the dinner given the visitors at the Midland Hotel, Manchester, E. Longdon presided. A. E. Hageboeck, Frank Foundries Corp., Moline, Ill., in proposing the toast to the city and trade of Manchester, spoke of the value of the experience to the foundrymen of the party, through visiting the outstanding shops of England. The lord mayor of the city, Col. G. Westcott, responded with remarks on the standing of the city in commerce and industry. T. Makenson, general secretary of the Institute of British Foundrymen, paid tribute to American foundry practice and acknowledged the similarity which characterizes castings manufacturing methods on the two sides of the Atlantic.

Speaks of Accomplishments

Fred Erb, Erb-Joyce Foundry Co., Detroit, paid tribute to Oliver Stubbs who visited America a number of years ago, one of the pioneers in promoting the international idea in the foundry world. Mr. Erb mentioned the inspiration to better accomplishment, whether between neighboring firms or different nationals, due to the interchange of ideas. Bernhard Dango, Dango & Dienenthal, Siegen, Germany, expressed the appreciation of the continental members of the party for the hospitality of the Institute of British Foundrymen. Daniel Adamson, president of the Institute of Mechanical Engineers spoke of the important accomplishments of the Lancashire branch in technical and personnel work among its members.

He was especially interested in the establishment of a junior section which the branch has undertaken to interest younger men in the foundry business. E. Longdon responded and spoke of the charm of studying metals and materials which when properly handled produce castings, so essential to modern industry.

Leaving Manchester early Saturday, June 1, the party traveled by motor coach through the industrial region which with the city of Manchester has a population of more than 14,000,000 persons. Thence the drive led through scenic and historical regions to the center of the English lake district, where an overnight stop was made at Keswick.

Sunday's tour completed the traverse of the lake region and terminated in Glasgow, Scotland, where a party of representatives of the Scottish branch of the Institute of British Foundrymen welcomed the party. Immediately thereafter an informal surprise reception was tendered S. T. Johnston, commemorating his birth date and the occasion of his arrival in his birthplace, Glasgow.

Tour the Clyde

Early Monday morning the entire party, escorted by members of the Scottish branch proceeded to Clyde bank, where a steamer had been chartered to proceed down the river, past hundreds of shipways and their accompanying shops, up the various lochs and about the beautiful islands and shore of the Clyde, terminating at Gourock where a special train was waiting to return to Glasgow.

The party then proceeded to the city chambers in the splendid old municipal building where short addresses of welcome were given by T. S. Park, the bailie representing the Lord Provost and S. R. Beale, president of the chamber of commerce. In his response, S. T. Johnston referred to his birth and boyhood in Glasgow where his father had been born on the present site of the municipal building.

The entire day, Tuesday, June 4, was occupied by a drive through some of the most beautiful parts of Scotland to Edinburgh, accompanied by members and ladies of the Scottish branch of the Institute of British Foundrymen

Attend Reception

Wednesday at the invitation of the Scottish branch, a short motor coach ride followed by a civic reception was tendered the visitors. Bailie Hay, alderman and deputy lord mayor delivered the address of welcome to which S. T. Johnston responded in the ancient city hall of Edinburgh. An afternoon drive to Newcastle-on-Tyne was followed by a reception by members of the Newcastle branch of the Institute of British Foundrymen.

Three exceptional plant visitations were offered the visitors Thursday morning, June 6. These were to the plants of Smith, Patterson & Co. Ltd., makers of railchairs, tunnel segments and miscellaneous castings, to the North Eastern Marine Engineering Co., and the plant of Sir W. G. Armstrong, Whitworth & Co. Ltd. In the latter plant the machine shops were inspected. A civic welcome and luncheon at noon was presided over by Colin Gresty, branch president, who introduced Alderman Millican, deputy lord mayor. His address was replied to by Fred Erb. The official welcome of the Newcastle branch by the chairman, Mr. Gresty, was responded to by Dan M. Avey, editor THE FOUNDRY, Cleveland. During the afternoon the visitors and ladies, accompanied by local people, were guests at the North-East Coast exhibition.

Exceptional courtesies were extended the party at Sheffield on Friday. The reception was given by the Master Cutler, Mistress Cutler and Mr. and Mrs. T. G. Sorby, of the Ancient Cutlers' Co. This was followed by a dance.

On Saturday morning the delegates visited many of the leading foundries and technical organizations, including the Brown-Firth Research laboratories; Cammell-Laird & Co. Ltd., foundry and sand research laboratory; Brightside Foundry & Engineering Co. Ltd. The ladies, during the morning, visited the plant of Walker & Hall, Ltd., silversmiths and cutlers.

At a luncheon tendered by the Lord Mayor, J. T. Goodwin, president of the Sheffield branch and past-president of the Institute of British Foundrymen, presided. Mr. Goodwin, in his remarks, spoke of the accomplishments of Sheffield in iron and steel metallurgy, in cutlery and in electroplating. He paid tribute to Thomas Firth, past-president of the Institute of British Foundrymen and one of the pioneers in the development of international co-operation in foundry matters.

In a short response, S. T. Johnston introduced S. Wells Utley, who spoke of the high quality of technical accomplishments and the exceptional hospitality displayed in the Sheffield reception. G. L. Oxley, president-elect of the Sheffield branch, expressed the appreciation of the local membership and the overseas delegates for the courtesies extended by the Lord Mayor and by the Cutlers' company.

Appoint British Agents

E. Gernelle-Danloy, 15 Rue Dous Vents, Rouen, France, has appointed Macnab & Co., 150 Holborn, London, E. C. 1, selling and manufacturing agents in the British empire, exclusive of Canada, for its sand milling and mixing machinery.

A River Trip From Glasgow to Gourock Was Enjoyed by the Entire Party

Questions & Answers on FOUNDRY PRACTICE

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall—Steel Casting
H. A. Schwartz—Malleable Cast Iron
J. W. Bolton—Gray Cast Iron

All questions should be addressed to The Editor, The Foundry, Penton Building, Cleveland.

MALLEABLE

Air Furnace Mixtures

QUESTION

In making malleable iron in the air furnace, what should be the relation of pig iron and scrap? What should be the composition of the pig iron purchased?

ANSWER

Generally, a mixture consisting of approximately 50 per cent pig iron, not more than 5 per cent steel scrap and the remainder hard iron scrap is used. This may be changed by the use of not more than 10 or 15 per cent annealed malleable in the place of some of the hard iron. The amount of steel also will be governed by the percentage of carbon in your resulting hard iron. This should be between 2.3 and 2.4 per cent to get the best results in physical properties. In case the carbon does not come this low, the steel may be increased above 5 per cent, but it should be spread out carefully in the furnace to insure a thorough mixture. If shrinkage in the metal becomes excessive, the amount of steel should be reduced.

Pig iron purchased should come within the following limits: Sulphur, not over 0.05 per cent; phosphorus, between 0.1 and 0.2 per cent, and manganese should average around 0.5 per cent. Silicon will be governed by the size of the castings you make. The pig iron should average about 0.4 per cent above the amount required in the finished castings. Since you cannot always obtain pig iron containing exactly 0.4 per cent more silicon, you will have to obtain several grades. For example, if you were making castings that required 0.9 per cent silicon, you would have to use pig iron containing 1.3 per cent silicon. To accomplish this you will have to buy some pig iron with a silicon range from 1.0 to 1.25 per cent, and some with a range from 1.26 to 1.50 per cent silicon. Calculation will show how much of each kind to use. It also will be useful to have small amounts of pig iron containing less silicon and some containing more than that given. For example, a small amount of pig iron containing 0.75 to 1.0 per cent silicon, and some containing 1.75 to 2.0 per cent will assist in obtaining better average mixtures.

Q & A

Finds Holes in Castings

QUESTION

We are experiencing considerable trouble with worm holes in a particularly heavy, double flanged, malleable casting. These holes appear on the surface at different parts but more frequently at or around the base of the feeding heads. The metal is not at fault because this casting is the only item affected in our daily operation. We have tried various grades of sand, vented the mold, skin dried them, poured the metal at varying degrees of temperature, but without success. We have made some of the flanges in dry sand cores, but the holes appear as usual. We have broken the flanges and have found them perfectly solid in the vicinity of these worm holes.

ANSWER

Apparently this is one of those cases where a painstaking and minute investigation of all the factors involved is essential, and that can be done only by an experienced foundryman on the ground. You have tried all the preventative measures usually employed, therefore it is apparent that the cause of the trouble is one out of the ordinary and will have to be discovered by assuming certain theories and by a process of elimination.

Basing our opinion on the description submitted, we are inclined to think that the ring core is responsible, either on account of its composition, or its lack of porosity. We suggest you try a special dry sand core, that is special to the extent that it contain a minimum amount of binder and is vented to an extraordinary degree, especially in the corner where the metal flows over the flange. Provide generous vent channels back of the core for the escape of the gas. If (as we are inclined to anticipate) you find that this remedy is effective, you may continue using dry sand cores or you may return to the green sand cores provided you take special precaution to see that they are made from a good, open grade of sand and that they are vented properly.

The defect to which you refer, occasionally has been traced to foreign material in the molding sand which under certain conditions causes a spurt of gas to enter the casting and remain imprisoned. A chemical analysis of the sand in your core will serve to either confirm, or remove your suspicions on this head.

GENERAL

Repair Melting Zone

QUESTION

What is the best material for repairing the melting zone in the cupola?

ANSWER

Local conditions to a certain extent determine what is the best material to employ for repairing the melting zone in a cupola. In a small cupola running on short heats ordinary mold-

ing sand mixed with water and applied in the form of thick mud will serve satisfactorily. On longer heats the same material mixed with varying proportions of silica sand and fireclay will answer the purpose. In other instances foundrymen find it more convenient and economical to use a mixture of fireclay and silica sand. In large foundries where a considerable amount of daubing is required every day, the mixture is prepared in a pan mill, and brick bats to the extent of 15 to 25 per cent are added to the mixture. The ideal mixture is one that is cheap, highly refractory, can be prepared and applied readily and one that will last until the end of the heat. The term silica sand in this instance embraces all free, washed sand, whether from disintegrated rock, from a pit or from sea, river or lake shore. Some of these deposits carry a certain amount of lime and other impurities and therefore are undesirable, but the majority will serve satisfactorily in a daubing mixture. In some foundries the spent sand from the sandblast units is employed. A typical daubing mixture is made up of 1 part fire clay and 1 part silica sand. The clay imparts the necessary sticking properties and the sand supplies the refractoriness. One or two trials will indicate whether to increase one of the ingredients and decrease the other to improve the quality and thus prolong the life of the material on the cupola wall.

Q & A

Galvanizes Fittings

QUESTION

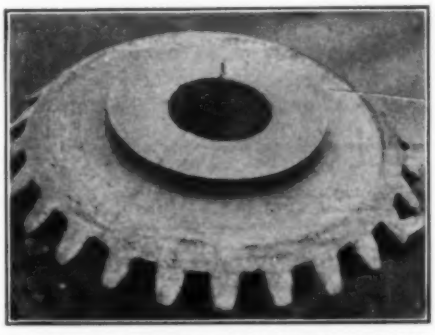
Can you give us any information on the process or method of hot dip galvanizing for gray iron fittings?

ANSWER

One of the important features of galvanizing is to have clean castings at the start of the operations. The castings may be cleaned by sandblasting. In case the castings are greasy or any residue from the core compound is left on the castings or they they have been faced with graphite or black lead they should be treated with an alkali bath. This bath may be a strong hot solution of caustic soda or soda ash. If the castings are rusted, sandy or scaled they should be pickled in a bath composed of: Hydrofluoric acid (30 per cent), 6 gallons; muriatic acid, 4 gallons; water, 40 gallons. This solution should be used warm but not hot. In any case after a pickle in either alkali or acid bath the castings should be washed well with hot water.

Hot water is a better agent for removing acid or alkali and it will assist the castings to dry quickly. Zinc may be melted in a cast iron pot. It should be supported suitably to sustain the weight of the molten material. Sufficient lead should be placed in the bottom of the kettle to give a layer of six or 8 inches to act as a cushion for the zinc. The zinc should be placed so that the slabs hug the sides of the kettle, and the kettle slowly heated. About 36 hours should be allowed for the melting of the bath. If the operation is hurried, the kettle may be ruined by overheating.

If the pieces to be galvanized are small and it is possible, they should be strung on wires about 2 feet



ONE OF A NUMBER OF STEEL PINIONS AND GEARS WHICH DEVELOPED CRACKS

long. The ends should be twisted together, after the castings are on, to form a loop. The bath for small-work should be heated to about 870 degrees. The surface of the bath should be covered with a flux composed of sal ammoniac and a few drops of glycerine added as soon as the flux melts. The castings are left in the bath for about a minute. The time of immersion may be determined by experiment. When the castings are removed from the bath, they should be given a shake to remove any excess zinc and prevent the formation of drops on the surface and to prevent the castings from sticking together.

Q & A

Patterns Are Warping

QUESTION

We are experiencing considerable trouble due to warpage of patterns in our pattern vault. Can you give us some information on the proper method of heating a pattern vault to prevent warpage of wood patterns?

ANSWER

The main essential of heating a pattern vault is to keep it at a uniform temperature. The temperature should be near that of the foundry, which in winter probably would be about 60 degrees Fahr. If the temperature gets too high, the patterns dry out, and when put into use in the foundry absorb water rapidly which causes warpage. Also, the pattern vault should be arranged so that it will not become damp. If this happens, you may be assured of many cases of warping.

One firm, a manufacturer of hot air furnaces, uses one of its furnaces to heat the pattern vault. Another firm, a large manufacturer of electrical apparatus, uses steam heat to keep its pattern vault at the proper temperature. With steam heat we should suggest that the venting of the radiators be carried outside the room as steam condensing in the radiators when cool, will be driven into the atmosphere when the radiators become warm again. This has a tendency to increase the moisture in the air to high percentages.

STEEL

Steel Castings Crack

QUESTION

The accompanying illustration shows a steel pinion having a vertical crack in the metal next the center core. The boss on this pinion is 6½ inches diameter with a 3-inch diameter core. The boss was carried up in full size for a riser. The core is oil sand. We find the same defect in other pinions, spur and helical. We have tried pouring the casting at the bottom, also at the top through the riser, but without affecting this particular type of defect.

ANSWER

The most probable cause of the crack in the center of the wheel is an exceedingly hard core which prevents the metal from contracting normally. Try a special core in which the binder has been reduced to a minimum. Dry this core almost to the point of burning. Provide a hole through the center 2 inches in diameter and fill this opening with dry ashes or with dried molding sand after the core is placed in the mold. This is merely a precaution to prevent molten metal from flowing in over the top. If the casting is molded in a manner that allows the core to extend through and above the top of the riser, the shell of the core does not need to be filled. A core of this kind will serve its purpose in forming a hole through the casting. What is more important it will crush readily and thus offer no opposition to the contracting metal. Also, it may be cleaned out of the casting more readily than a solid core. Incidentally a core projecting through the riser will effect a certain saving in the amount of metal and a ring riser will feed the casting as effectually as one that is solid. A possibility

also exists that the solid riser may be a contributory factor to the crack in the hub.

Q & A

Temperature Is Low

QUESTION

Our steel melter makes the following remarks in connection with annealing which is necessary to remove strains and meet specific physical tests: "Temperature of the steel should be raised gradually, and the castings should be uniformly heated to the required temperature which depends on the composition of the metal. The castings are soaked at the maximum temperature of 1170 degrees Fahr. for a time which depends on the size, and allowed to cool slowly without exposure to the air. I think our man is running the furnace up too quickly and does not allow the proper soaking time for the casting to attain a uniform temperature. A casting can be burned on the outside and still not have the heart annealed." The chemical analysis of the steel is 0.30 to 0.40 per cent carbon; 0.60 to 0.85 per cent manganese, and 0.30 to 0.60 per cent silicon.

ANSWER

We would suggest that you increase your annealing temperature to about 1600 degrees Fahr. At the temperature you are using (1170 degrees) we doubt that the castings are being benefited, to the extent that you desire.

The following method is used to obtain the best physical properties besides relieving any strains:

Heat to 1600 degrees Fahr., slowly and uniformly. This not only prevents undue stresses but also lessens the tendency to increase the temperatures above those desired so that the heating may be speeded up. The castings are then held at this temperature until all parts of the casting are at the same degree of heat. A comparative figure for this period is to allow at least one hour at the maximum temperature for every inch in thickness—thus a casting four inches thick would require at least four hours. The castings are then cooled by quenching in water, oil or air blast. As soon as the black heat is reached they are allowed to cool slowly.

Accelerated cooling is then followed by a secondary heating at a lower temperature. Castings quenched in oil or water should be reheated to 1200 degrees and held about 4 to 8 hours. Air cooled castings may be heated to 1250 degrees and held for the same period. This will assure the maximum toughness. The cooling is carried on in the furnace to a faint red and then cooled in the air. Oil or water quenching should be attempted only on castings of comparitively small shapes, and preferably after obtaining the advice of some one who has had experience with this work.

The first heating to the high temperature produces the proper grain size which should be of fine structure and the second heating removes any stresses and gives toughness and ductility.

Pyrometers that are frequently checked, should be used to aid in maintaining the proper temperatures. All the castings being annealed should be of the same color that the tip of the pyrometer shows. Do not stick a pyrometer in the furnace and let it go at that. Maintain a careful watch on the castings and see that directions are carried out. You fail to mention the percentage of sulphur in the steel. These elements must be held as low as possible. Sulphur causes red shortness and checking. Phosphorus reduces the resiliency or ability to withstand impact or shock.

GRAY IRON

Makes Mold Castings

QUESTION

We have been called upon to make some ingot molds for a zinc plant. They also ask for castings called rake bars to be used in the plant under temperature conditions ranging from 1200 to 1400 degrees Fahr. The oven in which they will be used will contain considerable sulphur. Can you help us out?

ANSWER

Since zinc melts at a relatively low temperature (786 degrees Fahr.) the molds will not probably have to stand a temperature more than 100 degrees above this temperature. Consequently, a mixture containing about 2 per cent silicon; phosphorus, 0.20 to 0.40 per cent; manganese, 0.60 to 0.90 per cent, and sulphur as low as possible, should turn the trick. A mixture of this composition is used for permanent molds so it should stand up well under the less exacting conditions. We suggest that you use a semi-steel mixture to give the finer and denser structure.

For the rakes for the zinc ore roasting furnaces, we suggest a white iron. This material will withstand the high temperatures it is exposed to, and also the abrading action from being drawn against the floor of the roasting hearths. White iron will contain from 0.50 to 1.0 per cent silicon; sulphur from 0.08 to 0.10 per cent; phosphorus, 0.30 to 0.60 per cent, and manganese from 0.40 to 0.60 per cent. White iron cannot be machined or drilled well, so if any work of this type is to be done, the silicon will have to be raised toward the gray side. Steel scrap in the mixture will prove beneficial.

Q & A

Is Not Combined Carbon

QUESTION

We are making a number of direct current motor bodies which have rather large pole pieces on the inside. These are gated on the outside with large risers or feeders on the inside feeding into the pole pieces. I noticed in breaking off the feeder that spots show in the fracture which are high in combined carbon. We feed up the risers after the castings are poured. Would pouring hot iron into the risers cause this or is it due to something else? The risers are about 2 inches in diameter. Sometimes two or three of these spots appear. The average spot is about ½-inch square. Our analysis shows 2.90 per cent silicon; 0.08 per cent sulphur; 0.35 per cent phosphorus, and 0.75 per cent manganese.

ANSWER

We are at loss to account for the spots high in combined carbon that you refer to in your letter if the analysis of your iron is correct. Iron with a silicon of 2.90 per cent hardly could be chilled in a 2-inch section even when poured against a chill block, let alone its occurrence from ordinary causes.

The sulphur in your castings is not high enough to warrant any segregation due to that element, and besides the manganese is high enough to prevent segregation.

It occurrs to us that the patches you notice, instead of being light colored due to high combined carbon, are patches of ferrite which is nearly pure iron. This may be due to large flakes of graphite peeling off and leaving the bare iron.

When graphite is in large flakes in cast iron it may be removed from the fracture to a great extent by brushing with a steel scratch brush. Try this sometime and see if you get the same appearance. However, if you have had these light patches analyzed and found them high in combined carbon, our theory is wrong. Then the only way we could account for this peculiar happening is that the iron from the cupola is not well mixed, and some iron of low silicon content, or if steel scrap is used, some of this material was used to pour the casting. Sometimes when steel is used without having a good sized mixing ladle at the spout, the first part of the charge containing iron low in carbon and tending toward white iron is caught in the ladles and poured. This may give castings that vary in color from white to gray.

Problems in Nonferrous Founding

By Charles Vickers

Fail To Meet Tests

We are about to make some bronze castings to conform to the following analysis and specifications: Grade 5: 40,000 pounds per square inch ultimate tensile strength; yield point, one-half of the tensile strength; elongation 20 per cent in 2 inches. Grade 6: 35,000 pounds ultimate tensile strength; yield point to be half of the tensile strength; elongation 18 per cent in 2 inches. The chemical analysis of Grade 5 shall show: Copper, 86 to 89 per cent; tin, 7.5 to 11 per cent; zinc, 1.5 to 4.5 per cent; lead, nothing to 0.3 per cent; nickel, 0.75 per cent; iron, 0.10 per cent; phosphorus, 0.05 per cent; sulphur, 0.05 per cent; antimony, 0.25 per cent; other elements, 0.15 per cent.

Grade 6: Copper, 85 to 89 per cent; tin, 7.5 to 11 per cent; zinc, 1.5 to 4.5 per cent; lead, 1 per cent max.; nickel, 0.75 per cent; iron, 0.25 per cent; phosphorus, 0.5 per cent; sulphur, 0.05 per cent; antimony, 0.25 per cent; other elements, 0.35 per cent. In the past we have experienced trouble in getting the test bars to pull the required tensile strength. Will you kindly give us a few pointers in regard to the above mixtures? What proportions should be used to give the required strength? We use heavy trolley wire, Straights tin, and prime western zinc. In what shape should the test bar be cast?

We suggest that grade 6 be made first to accumulate gates and ingot long enough for heats of remelt for grade 5. First get a representative sample of the trolley wire for analysis to determine whether or not, tin is in alloy. If it should contain tin, it will have to be allowed for in weighing out the tin for the heats. For grade 6 work to the following formula in making charges: Copper, 87½ pounds; nickel, ¾-pound; zinc, 1½ pounds; tin 10 pounds; and manganese-copper, 4 ounces. The manganese copper must contain 30 per cent manganese and be low in iron, as there is not much allowance for this element in the case of grade 5. In figuring the tin and copper allow for any tin content the analysis of the trolley wire may show. It would be better to use electrolytic ingot copper. Put the nickel in the bottom of the pot, or use any of the various alloys carrying nickel, such as the 50-50 copper-nickel alloy. Use charcoal and borax for a cover, and if possible melt in crucibles and have the metal bright and hot before pulling it from the furnace. As it stands this alloy will make the grade 6 easily, or something is wrong with the manner of melting. The manganese-copper is the deoxidizer and it is added when the copper is quite liquid, but not hot.

If crucibles and trolley wire are used, put a deepener on top of the pot and stand the wire therein. It should be cut to lengths that do not project beyond the top of the crucible. For the grade 5; cut up the gates from grade 6, and use them together with any ingot metal left over. For every hundred pounds of these gates and remelt, put 2 ounces of phosphor-copper in the crucible when charging, and melt with the copper. The result will be a metal that will make 40,000 pounds tensile easily if the work has been properly carried out. The test bars are important; the best forms of test bar pattern for such alloys are 2 rods of iron (casting 2 bars on a gate). The iron rods should be round, ¾-inch diameter and as long as the tensile machine operator desires, which will depend on the kind of grips used. Sometimes the bars are 9 inches long. The bars are laid parallel in a flask with space between to allow plenty room for a runner between them. One end of which will carry the sprue, the other, the branching gates to the bars. On the outer sides of the round test bar patterns, and in the cope lay a long feeder, containing 3 times the metal that is in the test bar as a minimum. Place these feeders ¼-inch away from the patterns and gate them with a continuous gate to the test bars that will be ¼-inch wide at the junction with the bar, and will slope up smartly into the feeder. This gate is cut three-fourths in the cope and one-fourth in the drag. Several needle vents are threaded through the top of the feeder to let the gas off through the cope. The flask is poured horizontally. The sprue is filled because the gates carrying the metal into the bars and feeders are choked to hold out dross. The feeder takes care of the shrinkage of its particular bar, solidifying it to the center.

Q & A

Withstands Pressure

We are running a coil connection casting which must be made of red brass and the pressure on these castings is around 1000 pounds per square inch. Our percentage of leaky castings at present is about 20 per cent, using 85-5-5-5 metal. Could you advise us of a metal that would stand this pressure and still machine easily?

The ancient name of 85-5-5-5 was ounce metal, because it was at first made by melting one pound of copper (or more) and adding one ounce each of tin, zinc and lead. It is not a particularly good alloy from the foundry standpoint, and it is usually improved by cutting the tin to 4 per cent and raising the zinc to 6 per cent, and sometimes the lead is dropped a per cent or two, the copper being increased. A trifle of phosphorus is also advisable for pressure resisting castings. A better alloy would be 87.50 per cent copper; 8 per cent tin; 1 per cent nickel; 3 per cent zinc, and 0.5 per cent lead with a small amount of phosphorus, maximum 2 ounces of phosphor copper per hundred pounds of alloy. Metal thickness figures largely in equation, but if 80 per cent of the ounce metal castings withstand the pressure, the stronger and denser alloy ought to do much better. A little nickel, one per cent or a trifle over usually is helpful in red brass subjected to pressures, but when it is used, a little phosphorus is also necessary. As regards easy machining, when this property is insisted on, the alloy must contain lead, and that means the physical properties of the alloys are lowered in proportion to the amount of lead added to the mixture.

CONTROL FEATURES

New Type of

Open-hearth Furnace

By Norman F. Hindle

CONTROL of the open-hearth furnace, designed by Arthur L. Stevens and now in operation at the Indiana Harbor plant of the American Steel Foundries, really begins with the advent of the materials into the plant. Sidings are provided from the Indiana Harbor Belt railroad, a subsidiary of the New York Central railroad, and the Elgin Joliet & Eastern railroad. Practically all the raw materials are shipped into the plant on these railroads. Upon the arrival of a car of material, the receiving clerk notifies the laboratory that the car is in the yard. The material is sampled and analyzed by the laboratory.

Material Is Unloaded

If it is found acceptable the material is unloaded in the yard or other storage place. Scrap and pig iron for the furnaces are piled in the yard according to kind and analysis. Ferroalloys, sand, coal, coke also are piled at various convenient places in the yard. Brick, sleeves and nozzles are stored under the charging platform for protection against climatic conditions. Fireclay, binders, etc., are stored in bins inside the plant.

One crew makes up all charges for the day and night shift. Charges consist of pig iron, both bessemer and low phosphorus; returned shop scrap consisting of gates, heads, sprues and scrap castings; steel wheels; billets, consisting of the sheared off piped ends of billets; forgings, and springs. The forgings usually consist of the ends of forged billets and the springs are of the coil type. The charge is loaded into charging boxes in the yard. The boxes are brought into the furnace room on a flat car which is spotted at the end of the charging platform. Each charging box is numbered and its weight is known. The charge is made up by weight and when each box contains the proper amount of pig iron or scrap, a crane places it on a buggy as is shown in Fig. 3. The buggies run on a narrow gage track that crosses the charging platform and are pushed into the position in front of the furnace door by the charging machine.

Describes Control

CONSIDERABLE interest has been created by a new type of open-hearth furnace which now is in operation at the Indiana Harbor plant of the American Steel Foundries. This article is the second and concluding section of a description of the furnace. The first installment appeared in the June 15 issue of THE FOUNDRY *on page 502. This article presents the principles upon which the operation of the furnace is based and describes the methods of control. The general procedure in the manipulation of a heat is given and analyses of the bath at various times during that period also are presented.*

In any open-hearth furnace the necessary oxidizing reactions in the bath are produced by elements introduced into the material that has been charged. Therefore, oxygen is the one element introduced into a furnace which is controlled entirely by the judgment of the melter. Steel is made in practically a neutral atmosphere in the new furnace. Because of this fact, there is less reduction of carbon in the furnace and consequently less pig iron is needed in the charge. It also follows that since there is less oxidized metal the yield is increased. This has been found by actual operating conditions to be a fact. The average normal melting loss on an open-hearth furnace is approximately 8 per cent. With the new type furnace on a regular run of four heats per day, six days per week, the melting loss is approximately 6 per cent.

Another feature of the furnace is the fuel economy. This is claimed to be due to design and method of operation which prevent losses previously accepted as necessary in commercial operation. The economies in the new furnace may be illustrated by a comparison with the usual type of open hearth built and operated to use 30 per cent or more excess air. This excess is variable as there is no method of controlling it.

Reduces Air Leakage

As intake of air is dependent upon differential temperature and pressures in the furnace and stack, it is customary to maintain a stack draft that will reduce the gas pressure over the bath to a point considerably below atmospheric pressure. This low pressure assists in the intake of air through door openings, sight holes, etc.

For the purpose of illustration, assume that the excess air amounts to 30 per cent and that the furnace is burning fuel oil that requires 9.171 cubic feet of air for each 1000 B.t.u. produced. Then with 30 per cent excess air, the total volume of gases becomes 13.1 cubic feet and, if one-third of the excess is infiltrated without preheating, an approximate heat balance may be made as follows:

Due to the specific heat of the gases leaving the melting chamber at an estimated average temperature of 2700 degrees Fahr., it is estimated that 90 per cent or 900 B.t.u. will be carried out of the furnace to the regenerators. Since one-third of the excess air is infiltrated, 11.791 cubic feet of air will be introduced through the regenerators to be heated. If the temperature of the ingoing air is 70

degrees Fahr. and its temperature is raised 2000 degrees Fahr., that volume will absorb 488 B.t.u. The initial input, 1000 B.t.u., plus that amount or 1488 B.t.u., must perform all the work in the furnace. From this must be deducted the heat required to raise 11.791 cubic feet of air from 2070 degrees Fahr. to 2700 degrees Fahr. This amounts to 158 B.t.u. The heat required to raise 1.31 cubic feet of infiltered air from 70 degrees Fahr. to 2700 degrees Fahr., 73 B.t.u., also must be deducted from the total. In addition the brick absorption and radiation loss may be assumed to be about 190 B.t.u. Adding the losses gives a total of 1321 B.t.u. That amount deducted from the total heat available for work in the furnace, 1488 B.t.u., gives 167 or 16.7 per cent of the heat value of the fuel that is available for heating the charge based on the previous assumptions.

Gives Heat Balance

Using the same method of reasoning on the type of furnace in operation at the Indiana Harbor plant of the American Steel Foundries the heat balance shown in Table II is calculated. In this type furnace the temperature of the air from the regenerators is raised about 200 degrees Fahr. higher than in the older type furnace. This would increase the efficiency of the furnace still more.

Based on the data in Table II it will be necessary to reduce the oil consumption much lower to realize the higher efficiency. The figures for the oil consumption of the furnace show a considerable reduction over those obtained on the older type furnace. With the best possible operating conditions with the older type furnace, the oil consumption per ton of metal charged was approximately 47.0 gallons per ton from charge to tap. The new furnace gives an average of about 27.0 gallons of oil per ton of charge from charge to tap. The average for February was 30.1 gallons per ton of metal charged and that figure included the oil that was used in making bottoms and keeping heat in the furnace over Sundays when the furnace was not in operation. Figures for March show an average of 29.6 gallons of oil per ton of charge under the same conditions.

These increases in fuel economy are accomplished by supplying the air for combustion at constant pressure. The volume of the air is measured and calibrated to the quantity of fuel used. Flue gas analysis taken at the outgoing slag pocket shows no unconsumed combustible and only a trace of oxygen, usually about 0.2 per cent or what would represent approximately 1.0 per cent excess air. Thus the air is independent of the stack and draft and can be increased to meet requirements of combustion without increasing the draft pressure. The regulation of the draft in the furnace is accomplished by the regulators shown in Fig. 10. Stack draft is used only to remove the waste gases from the furnace and to maintain a slight pressure difference between the melting chamber and the outside.

Table I

Data Obtained on New Open-hearth Furnace

Estimated composition of charge	C—0.85 Mn—0.90 Si—0.50 P and S below 0.045
Composition of charge at melt	C—0.60 Mn—0.11 Si—0.10 P and S below 0.045
Composition of bath before final additions	C—0.24 Mn—0.08 Si—0.02 P and S below 0.045
Furnace sand used	Silica 96 per cent
Specific gravity of oil	18-22 degrees Baume
B.t.u. value of oil	19,000 per pound
Temperature of oil at burner	140 degrees Fahr.
Temperature of superheater	900 degrees Fahr.
Temperature of metal	2700-2800 degrees Fahr.
Gas analysis	14 per cent CO_2
Design of burner	Special design by A. L. Stevens, Chicago
Steam or air pressure during gassing period	55 pounds per square inch
Oil pressure during gassing period	40 pounds per square inch
Steam or air pressure during melting period	45 pounds per square inch
Oil pressure during melting period	35 pounds per square inch
Average gallons per ton charge of oil from charge to tap on Stevens designed furnace	27.0 gallons
Average gallons per ton on old type furnace	47.0 gallons
Stack temperature	800 degrees Fahr.
Checkers first cleaned	1502 heats
Differential pressure across bath	0.03 inches of water

Construction of Checkers

The regenerators of the furnace are designed so that the weight of brick is proportional to the maximum duty required based upon the mean mass variation in temperature and the diffusivity of the brick derived from their conductivity, specific heat and density. This method of construction makes the thickness of the brick a function of the time for reversal.

Another feature of the new type furnace is the reduction in the volume of gases and their velocity through the furnace. This decrease in volume and velocity results in less dust and slag being carried over into the regenerators and the cutting and fluxing of the refractories is reduced greatly. The reduction in volume of gases may be illustrated as follows:

The volume of waste gases as standard measurements from the burning of one gallon of fuel oil without excess air is approximately 1505 cubic feet. With a 30 per cent excess of air, 603 cubic feet are added making a total of 2108 cubic feet. With a 50 per cent reduction in fuel or in this instance ½ gallon of oil without excess air, the volume becomes 752 cubic feet or about 35 per cent of the previous amount.

Recently the checkers were cleaned for the first time after taking off

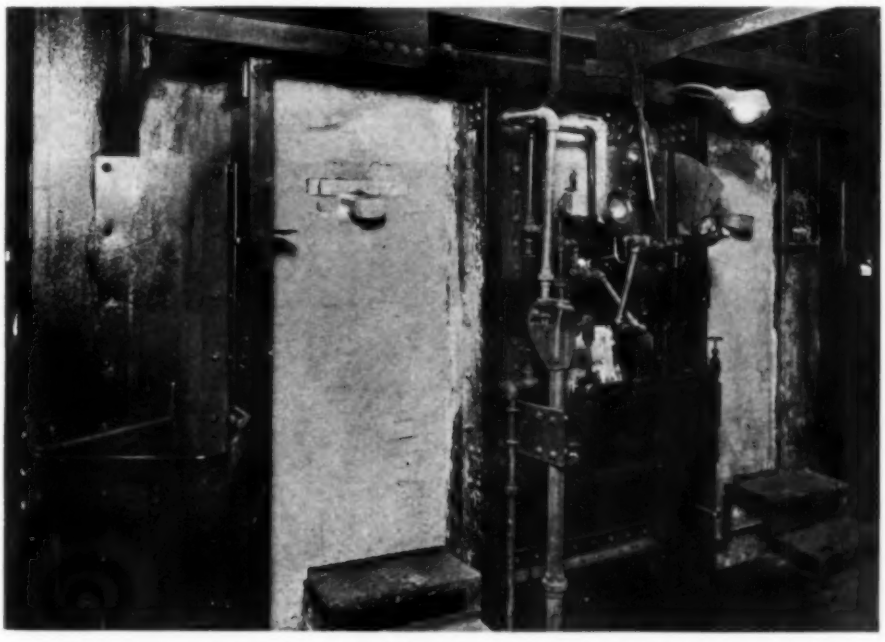


Fig. 7—Burner Construction Is Shown at the Right and the Reversing Lever at the Left

Table II

Heat Balance for Newly Designed Furnace

	B.t.u.
Waste gases leaving outgoing ports without excess air	730
Heat required to raise 9.171 cubic feet of air from 2070 degrees Fahr. to 2700 degrees Fahr.	123
Brick absorption and radiation	190
No excess air so no heat is required to heat it	0
Total heat losses	1,043
Heat from combustion of oil	1,000
Heat reclaimed from regenerators	379
Total heat available	1,379
Heat supplied to furnace	1,379
Heat losses	1,043
Heat available for melting charge or 33.6 per cent of total heat value available from fuel	336

1502 heats and the refractories in the furnace were in good condition indicating that they were good for many more heats. This evidence appears to bear out the theory advanced previously concerning the amount of slag and dust carried to the regenerators and the reduction in the cutting of refractories.

Use Soft Tap Hole

Practice on the new type of open-hearth furnace due both to design and the necessity of rigid control, varies somewhat from that generally used on open-hearth furnaces. After a heat has been tapped, the tap hole is closed. A *soft* tap hole is used on this furnace, consisting of a mixture of 3 parts coke and one part sand which is rammed into the tap hole and is backed up with wet sand. The coke mixture is dependent upon the size of the tap hole. When the heat is ready to be tapped the second and third helpers go to the front of the furnace, remove the rammed material from the tap hole and poke out the heat with a specially made bar.

When the tap hole has been closed, it is necessary to *make bottom*. This consists of filling that part of the bottom or hearth which has been cut away during the preceding heat. Since this furnace has an acid lining, sand is used for the purpose. The sand is termed *furnace sand* commercially and analyzes about 96 per cent silica. During the period when the hearth is being repaired, the fuel is turned off, but as soon as the repair operation has been completed, the heat is turned on in the furnace. A hot flame is used to burn in the sand because it gives a quick fusing action. The operation of making bottom and fusing the sand takes about 15 minutes.

The furnace then is ready for charging. The boxes containing the charge are picked up by the charging machine and rotated in the furnace to discharge their burden on the hearth of the furnace. The material is placed in the furnace in the following manner: Pig iron is placed on the bottom of the charge and shop scrap is used to complete the bottom layer of the charge. Scrap then is charged in the following order: Wheels, billets, forgings, and springs. The top of the charge is made of shop scrap.

Fuel oil is used to furnish the heat for the furnace. The oil shows by analysis 18-22 degrees Baume specific gravity, and the sulphur content must be below 0.5 per cent. The B.t.u. value is about 19,000 per pound. Superheated steam generally is used to atomize the oil but the burners also are equipped to use compressed air. Steam is furnished direct from the main steam line and is passed through the superheater which is situated in the outside flue of the furnace and which can be seen at the right in Fig. 8. If air is used to atomize the fuel, it also is passed through the superheater. The fuel oil is circulated through a heating coil to increase its fluidity and is delivered at the burner at a temperature of 140 degrees Fahr.

A hot flame also is used during the first part of the melting period. During that period the oil pressure is about 40 pounds per square inch and the steam or air pressure, as the case may be, is about 55 pounds per square inch. This condition persists in the furnace until the *gassing period* begins. At that point the oil pressure is reduced to about 35 pounds per square inch and the steam or air to 45 pounds per square inch.

The so-called gassing period is the time when the charge begins to melt. During this period the metal is giving off gas and continues to do so until the charge is *under cover* or in other words, until the charge is fairly well melted and covered with slag. The gassing period usually begins about 1½ hours after the furnace has been charged. The charge is melted in from 4 to 4½ hours from charging time.

Estimates Carbon

When the charge is melted, the melter takes a test and from the size of the crystals in the fracture, determines the carbon content of the bath and decides whether or not it is necessary to add iron ore to the bath to reduce the carbon. If he decides ore should be added, he estimates the amount and adds it to the bath. This is a case of judgment on the part of the melter and good judgment only is obtained by experience.

Estimated composition of the charge is approximately as follows:

Element	Per cent
Carbon	0.85
Manganese	0.90
Silicon	0.50
Phosphorus	Below 0.045
Sulphur	Below 0.045

The analysis of the bath at melt shows:

Element	Per cent
Carbon	0.65
Manganese	0.08-0.11
Silicon	0.10
Phosphorus	Below 0.045
Sulphur	Below 0.045

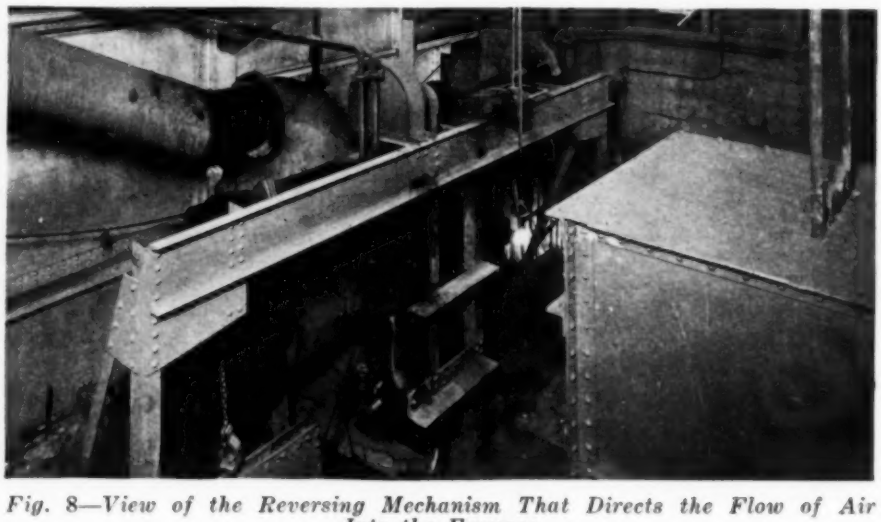


Fig. 8—View of the Reversing Mechanism That Directs the Flow of Air Into the Furnace

Analysis of the bath before final additions of ferromanganese and ferrosilicon is as follows:

Element	Per cent
Carbon	0.24
Manganese	0.08
Silicon	0.02
Phosphorus	Below 0.045
Sulphur	Below 0.045

When the iron ore is added to the bath, the charge enters what is termed the refining period. During that period the furnace is given the undivided attention of the melter. The heat of the flame is increased to heat the bath so that it will be at the correct temperature when tapped. During this period the slag is *worked* into condition and samples of the steel in the bath and samples of slag are taken to note the carbon drop in the first case and to determine the condition of the slag in the second. The slag, Analysis of the slag used on the furnace shows a silica content of between 55 and 60 per cent.

The iron ore always is allowed to remain in the furnace at least one hour before the final additions are made. When the bath is in the proper condition, closely approaching the analysis of the bath before final additions as given previously, the ferromanganese is added. Five minutes later, the ferrosilicon is added and 15 minutes later the heat is tapped. Ferromanganese containing 78 to 82 per cent manganese and ferrosilicon having 48 to 52 per cent silicon is used. The heats are tapped into two ladles, preheated with oil. The metal leaves the furnace at between 2700 and 2800 degrees Fahr.

Receives Appointment

John L. Connors has been appointed assistant general manager of the Jeffrey Mfg. Co., Columbus, O. He was born in that city and formerly was engaged in business there but for the past nine years he has been president of the Morgan-Gardner Electric Co., Chicago. He was educated at Ohio State and Purdue universities, graduating in 1905 from the latter school. In his new field of endeavor, Mr. Connors will have special duties and responsibilities in connection with the management of the subsidiaries of the company.

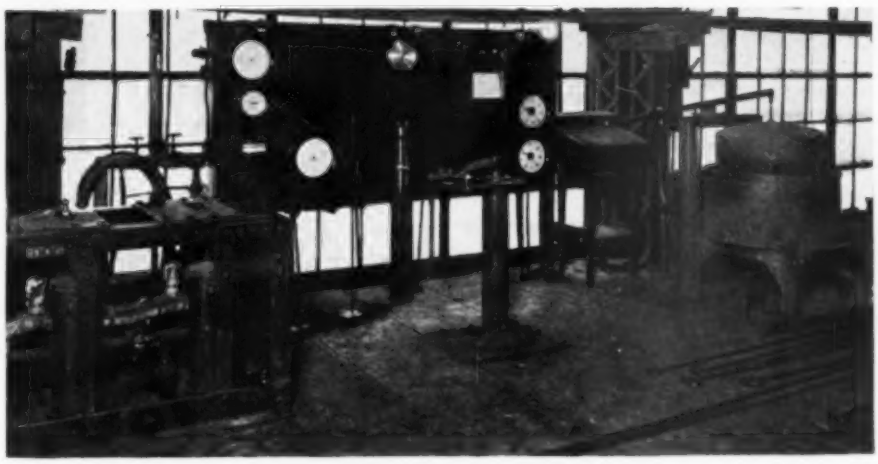


Fig. 10—Instrument Board and Control Apparatus. At the Left Are the Levers That Operate the Doors

Open School and Exhibit

The Westinghouse Lamp Co., New York, has started an extensive educational campaign through its lighting institute which has opened headquarters and an exhibit on the seventh floor of the Grand Central Palace, New York.

The space covered is equal approximately to that of a city block. The various features of the display are arranged in the form of a miniature city with a main street 180 feet long and a cross street 85 feet long. The city contains a theater, a school, several full size stores, a bank, a factory and an automobile service station.

After passing through a large reception room lighted with 16 luminous pilasters and a public hall, 18 x 38 feet, with unusual indirect lighting effects, the visitor passes out on Main street where different examples of street, window and display lighting are shown. From that street he may enter the various rooms. The industrial room, 40 x 44 feet, illustrates the effect of different intensities of illumination and also shows local lighting with special application to individual machines. An interesting feature is an automatic control of illumination designed to keep intensity uniform in a factory. When daylight begins to fade and the intensity of light at the machines drops to a low point making work difficult, a photo-electric cell is affected and automatically operates switches which turn on the artificial illumination. A complete miniature electric railroad in operation is shown in the transportation room.

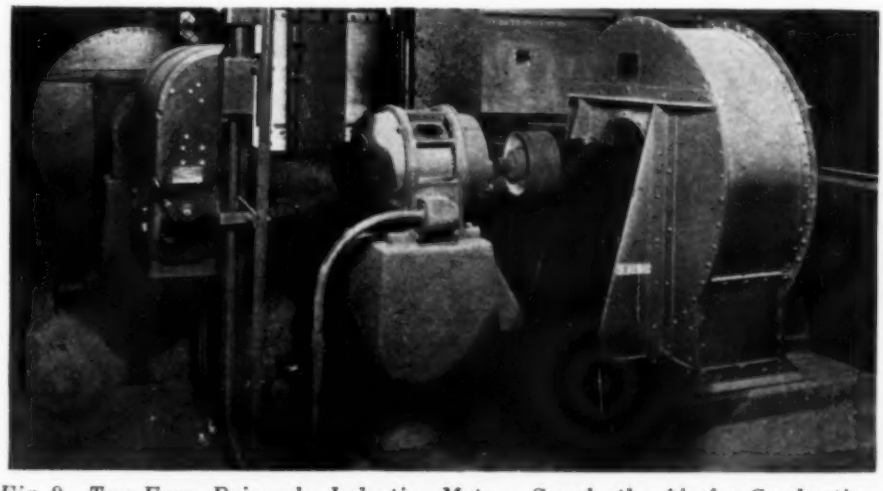


Fig. 9—Two Fans, Driven by Induction Motors, Supply the Air for Combustion in the Furnace

Join Equipment Company

L. B. Brewster and H. C. Nicholas, formerly of the Brewster-Nicholas Co., 4169 West Twenty-fifth street, Cleveland, have joined and merged their business with the western division of the New Haven Sand Blast Co., Cleveland. Both Mr. Brewster and Mr. Nicholas have had extensive experience in the sale and application of cleaning room equipment with the Brewster-Nicholas Co., and the W. W. Sly Mfg. Co., Cleveland. The personnel of the western division of the New Haven Sand Blast Co. consists of S. S. Parsons, western manager; Lawrence Thompson, sales manager; Robert Wisely, sales engineer in charge of the Chicago district; L. B. Brewster, sales engineer in charge of Ohio, western New York and western Pennsylvania, and H. C. Nicholas, sales engineer in charge of Michigan and western Ohio territory.

Test Bar Results

Approximate Properties in Casting

Progress Being Made Indicates that Accuracy Will Be Comparable with Methods of Testing Steel

By John W. Bolton

Part II

FROM the previously mentioned data it is possible to solve the first problem (study of the influence of manufacturing practice on given grades of cast iron) as follows:

Arrange a classification of irons according to composition; and make an intensive study of each grade. In this study it is necessary to give consideration to the influence of the four factors indicated in the first section of this paper in the June 15 issue of THE FOUNDRY. Although there are vast gaps in the data necessary, methods of statistical research can be applied to good advantage on existent data.

A list of several interesting compilations of data is included. A partial study of one grade of iron is shown in Fig. 7 and in Table III. In general there is a good agreement between all results except that of Prof. Kommers on the American Society for Testing Materials arbitration bar. In case of the 1-inch bar, Rother and Mazurie stated that they used an 0.875-inch tensile bar. No mention is made of special centering devices and it would seem hard to obtain a bar 0.875-inch in diameter with threaded ends out of a 1-inch test piece. Bolton used a 0.505-inch bar which is small. On the 1.20 and 1.25-inch bars, Bolton used a 0.686-inch bar while Fletcher probably had a 0.800-inch bar which should be slightly stronger as it would not contain quite so great a portion of the weaker center. On both the 2 and 3-inch bars Bolton used a smaller test piece than Rother which would explain a difference as experienced in heavy sections. As shown by the author in *Iron Age*, Jan. 3, 1924, pouring temperature has more influence on the large bars. Along this line the following tests were made from a 2-inch bar:

Diam. inches	Tensile lb./sq. in.
1.38	14,021
0.800	13,485
0.505	12,875

Differences in molding practice have much to do with the soundness of metal. In bronze a change to a smaller flask with a larger gate made 3000 pounds average difference in tensile strength, using the same pattern and pouring temperature.

The author has compiled data covering many of the groups, and regrets that space is not available for

Must Study Factors

BY APPLYING the results of a careful study of all factors entering into the manufacture of castings to the production of the test bar, the investigator may draw conclusions from the physical tests of the bars that will check closely with those obtained from the casting. This is shown clearly in the data published in this article, which is the concluding installment of two describing some interrelationships in gray iron metallurgy.

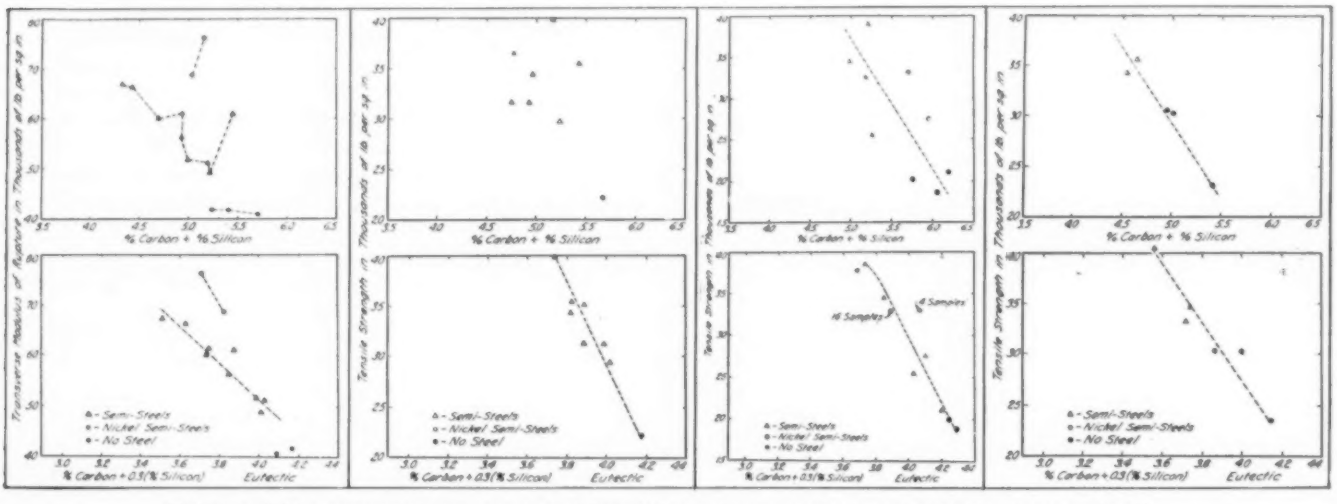


FIG. 5—CURVES SHOWING RELATION OF STRENGTH TO SUMMATION OF CARBON AND SILICON

inclusion of this voluminous, yet interesting, substantiation of the practicability of the scheme of study. While the complexity of the problem denies exact mathematical prediction of each and every property, it is unquestionable that most of these will some day be charted to a degree of accuracy compatible with usual engineering practice. An exact analogy can be drawn to the art and science of the manufacture and testing of steel, wherein reasonably accurate engineering data can be found in many handbooks on the subject.

relation is so well recognized in America that leading specification making bodies are proposing inclusion of such directions in specifications so that test and operating conditions may be correlated as nearly as possible.

Example 1. The casting of design shown in Fig. 4, was probed thoroughly. The volume-surface area relationship of this casting (overall) is 0.61, corresponding approximately with test bar 2.4 x 18 inches. However, the casting is not uniform in section and allowance should be made for

T2. Taking T1 and T2 average value (37,368 pounds per square inch) as representative of the casting, whose relative cooling rate approximates that of a 2.4-inch bar, we may compare it with the value 37,800 per square inch taken from the author's data. This is a good check when one considers that the tensiles T1 and T2 were taken from a section subject to some shrinkage. The brinells (195-203) when compared show that these check up with the tensile within the limitations of the brinell correlation. Following this same method of check-

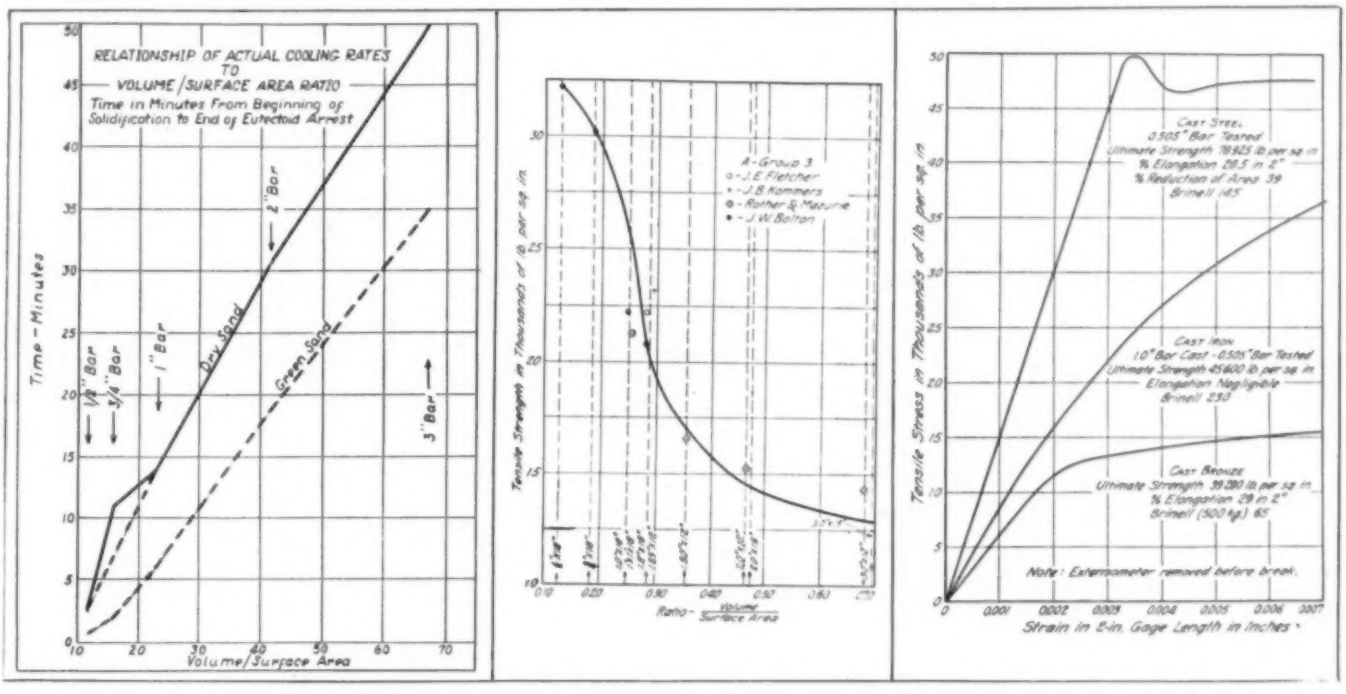

RELATIONSHIP OF ACTUAL COOLING RATES TO VOLUME/SURFACE AREA RATIO
Time in Minutes From Beginning of Solidification to End of Eutectoid Arrest
Time - Minutes
Volume/Surface Area
Dry Sand
Green Sand
2" Bar
1" Bar
3/4" Bar
1/2" Bar
3" Bar
A - Group 3
J.E. Fletcher
J.B. Kommers
Rother & Mazurie
J.W. Bolton
Tensile Strength in Thousands of lb. per sq. in.
Ratio - Volume / Surface Area
Cast Steel
0.505" Bar Tested
Ultimate Strength 78,925 lb. per sq. in.
% Elongation 28.5 in 2"
% Reduction of Area 39
Brinell 145
Cast Iron
1.0" Bar Cast - 0.505" Bar Tested
Ultimate Strength 45,600 lb. per sq. in.
Elongation Negligible
Brinell 230
Cast Bronze
Ultimate Strength 39,280 lb. per sq. in.
% Elongation 29 in 2"
Brinell (500 kg.) 65
Note: Extensometer removed before break.
Tensile Stress in Thousands of lb. per sq. in.
Strain in 2-in. Gage Length in Inches

FIG. 6—RELATION OF COALING RATE TO VOLUME TO SURFACE AREA RATIO. FIG. 7—GRAPHICAL REPRESENTATION OF A STUDY OF ONE GRADE OF IRON. FIG. 8—STRESS-STRAIN DIAGRAMS OF VAROUS IRONS

The second problem is relationship of test results to the properties of castings. Two viewpoints predominate—that of many British and Americans, who believe that test results can be correlated so that properties of castings may be predicted therefrom with reasonable accuracy, and that of the French and other Continental investigators, who hold that tests must be made on the castings themselves. It is logical to expect that if a ladle of the same grade of iron is divided into two parts and each part subjected to exactly the same treatment, the two resultant materials will be the same. Few articles have been published in which definite attempts have been made to make test piece and casting each comply with the four factors listed previously.

That it can be done, may be demonstrated by one example and summaries of other tests—all much condensed. The possibility of such cor-

this fact. This was a scrap casting due to blowholes in portions indicated. The analysis shows carbon 2.93 per cent, silicon 2.01 per cent, corresponding to group 27 or 28 of Table I. A detailed list of the test accompanies the diagram:

Tensile	T1	35,507
Shear	1B	41,875
	2B	44,652
	T2	39,265
Shear	1C	45,946
	2C	45,650
	3C	46,418

All these tests from casting.

Brinell, edge, average	203
Brinell, rib, average	195

Tensile T2 is slightly higher than T1, the latter being in the heavier portion of the rib. Shears 1B and 2B are close to T1, their average 43,263 pounds per square inch transferred to tensile in shear-tensile chart, Bolton, *Transactions*, A. F. A., 1928.

The average of shear strengths 1, 2 and 3C, 46,005 pounds per square inch corresponds to a tensile of about 38,000 pounds per square inch as shown in Fig. 9. This is comparable to 39,265 pounds per square inch of

ing the actual strengths of castings with calculated strengths some 6 typical examples are cited as follow:

Example 1. (previously given) Actual tensile strength 37,368 pounds per square inch; calculated tensile 37,800 pounds per square inch.

Example 2.—125-pound casting of uniform section. Actual shear 31,345 pounds per square inch average, calculated tensile strength 31,525 pounds per square inch.

Example 3. — 730-pound casting, complicated shape, uniform section. Actual tensile strength 28,433 pounds per square inch average; calculated tensile 22,500 pounds per square inch. A small choke gate was used, samples cut from far side.

Example 4. —700-pound casting, sections 1 to 1½-inch. Actual tensile 28,843 pounds per square inch average, calculated tensile 25,030 pounds per square inch.

Example 5. —325-pound casting. Actual tensile 27,055 pounds per

square inch average, calculated tensile 26,000 pounds per square inch.

Example 6. —300-pound casting. Actual tensile—22,250 pounds per square inch. Calculated tensile 21,-250 pounds per square inch.

All these examples were made on commercial castings, of reasonably complicated design. All but example No. 1 were cored castings, and variations in section were those encountered in sound engineering practice. Although the results obtained represent direct tests that have been made, it is conceivable that greater variations may be found in practice. However, it is believed that greater variations usually will be explicable on comparison of the factors influencing the bars and castings that are under consideration at the time.

Calculated data were obtained from test bars which, excepting Example 1, were *not* cast on the same day as the castings, but were from the same cupola and quite close to the same analysis. As in Example 1, tests on stress-strain diagrams, brinell and shear were made. Some of the calculated data were interpolated

Table III

Chemical Analysis and Physical Properties of Specimens

SUPPLEMENTARY DATA FOR FIG. 7.

A—GROUP 3

Reference Serial	Total Carbon	Silicon	Combined Carbon	Manganese	Sulphur	Phosphorus	Diameter Cast	Transverse Load	Deflection	Span	Transverse Mod. Rupture	Tensile	Tensile Diameter Pulled	Shear	Diameter Sheared	Brinell 3000 KG	Rockwell B	Percent Steel	No. Bars averaged	Sp. Gravity
1	3.52	2.17	.73	.60	.08	.32	.50	199	.73	18	73,000	32,317	.375	41,550	.358	....	96	6	5	7.181
2	3.59	2.14	"Crane Pattern" ½" Diam.					....	....	..	.....	32,500	.50	.....	....	....	..	6	1	....
3	....	Max. tests ½" bars						203	....	..	.....	33,760	.375	.....	....	....	..	6	..	....
4	3.52	2.17	...	.60	.08	.32	.75	566	.49	18	60,830	30,243	.505	38,800	.505	180	90	6	6	7.112
5		Max. tests ⅜" bars						600	....	..	.....	30,534	.505	.....	....	....	..	6	..	....
6	3.52	2.17	...	.60	.08	.32	1.00	1191	.275	18	51,290	22,205	.505	32,850	.505	162	88	6	4	7.116
7	....	Max. test 1.0" bar						1275	....	..	.....	22,725	.505	.....	....	....	..	..	..	....
8	3.52	2.10	...	.60	.10	.34	1.06	1917	....	12	53,900	21,250	.875	.....	....	....	..	0	3	....
10	3.54	2.20	.56	.64	.07	.27	1.20	1922	.276	18	50,900	22,125	.686	.....	....	154	85	6	12	7.094
11	3.52	2.14	.48	.49	.12	.63	1.20	.....	....	18	47,500	22,450	....	.....	....	....	..	0	2	....
12	3.68	2.17	.55	.54	.08	.65	1.25	3450	.123	12	54,000	23,200	.33	.....	....	172	87	0	5	....
13	3.68	2.17	.55	.54	.08	.55	1.25	.....	....	12	.....	24,900	.60	.....	....	....	..	0	5	....
14	3.52	2.10	...	.60	.10	.34	1.03	2450	....	12	40,400	square		.....	....	....	..	0	3	....
15	3.52	2.10	...	.60	.10	.34	1.55	7725	....	12	37,200	square		.....	....	....	..	0	3	....
16	3.52	2.10	...	.60	.10	.34	1.57	5975	....	12	46,600	16,500	.875	.....	....	....	..	0	3	....
17	3.53	2.09	.58	.52	.05	.84	2x1	2085	.34	24	37,500	.....	....	rectangle	....	....	..	0	6	....
18	3.52	2.17	.29	.60	.08	.32	2.00	7170	.165	18	41,075	13,485	.800	24,325	.505	112	..	6	3	7,087
19	3.52	2.10	...	.60	.10	.34	2.06	12267	....	12	44,000	15,330	.875	.....	....	....	..	0	3	....
20	3.52	2.10	...	.60	.10	.34	2.03	15667	....	12	33,700	square		.....	....	....	..	0	3	....
21	3.52	2.10	...	.60	.10	.34	2.55	27450	....	12	29,650	square		.....	....	....	..	0	3	....
22	3.52	2.10	...	.60	.10	.34	2.55	21450	....	12	39,950	15,130	.875	.....	....	....	..	0	3	....
23	3.52	2.17	.29	.60	.08	.32	3.00	18173	.118	18	30,840	11,561	.800	20,500	.505	94	..	6	3	6.972
24	3.52	2.10	...	.60	.10	.34	3.08	35517	....	12	37,100	14,270	.875	.....	....	....	..	0	3	....
25	3.52	2.10	...	.60	.10	.34	3.05	45067	....	12	28,600	square		.....	....	....	..	0	3	....

Reference Numbers

J. E. Fletcher—*Foundry Trade Journal*, July 21, 1927—11
J. B. Kommers—*Proc.* A. S. T. M. 1928—12, 13
A. N. Talbot—17
W. Rother & V. Mazurie—*Trans.* A. F. A. 1926—8, 14, 15, 19-22, 24, 25
J. W. Bolton—1-7, 18, 23

Coefficient of Expansion (average 70-1000 degrees Fahr.)

		(Average 21-538 degrees Cent.)	
½-inch test bar	0.00000737 per degree Fahr.	½-inch test bar	0.00001327 per degree Cent.
¾-inch test bar	0.00000736 per degree Fahr.	¾-inch test bar	0.00001325 per degree Cent.
1-inch turned to ¾-inch	0.00000694 per degree Fahr.	1-inch turned to ¾-inch	0.00001249 per degree Cent.
2-inch turned to ¾-inch	0.00000744 per degree Fahr.	2-inch turned to ¾-inch	0.00001339 per degree Cent.
3-inch turned to ¾-inch	0.00000737 per degree Fahr.	3-inch turned to ¾-inch	0.00001327 per degree Cent.

Growth (6 reversals, over 100 hours test)

¾-inch bar from 1.20-inch bar grows 0.00000008-inch per inch per hour at 750 degrees Fahr.
¾-inch bar from 1.20-inch bar grows 0.589 per cent in 100 hours at 1000 degrees Fahr.
125 times as fast at 750 degrees Fahr.

Uniformity Rockwell Hardness—See *Trans.* A. F. A. 1928 (J. W. Bolton, p. 469-512)

B 46 (Center) 39-38-58-59-67-66-65-59-60-69-69 (Edge)

Drop Test—Anvil 5 inches between supports. Hammer 20 pounds

Size	Started at	*Broke at*	*Times Struck*	Size	Started at	*Broke at*	*Times Struck*
½-inch	20 inch pounds	40	2	1-inch	50	120	8
¾-inch	40	70	4	*2-inch	200	1100	30

*Note: The 2-inch bar was struck 28 times, advancing by 20-pound increments to 740 inch pounds then raised to 1000 and broke at 1100 inch pounds.

Fatigue Limit

J. B. Kommers found the fatigue limit 11,800 pounds on R. R. Moore machines.

Impact Value

J. B. Kommers, using a Russel impact machine, 12-inch span, found an impact value of 16.5 pounds per cubic inch, energy of rupture.

from curves. From consideration of all these tests, the following opinions are justified.

Reasonable correlation of tests to the properties of the castings themselves must be established or cast iron research is futile. It is the casting that the engineer designs, the manufacturer sells, and the customer buys. These men care little about the *quality* of the iron in the ladle. They are concerned only with what they get, namely, the casting. However, it is possible to tell a great deal about the quality of the metal in the casting, as is evident from the following considerations:

Many working properties of steel and other metals are predicted regularly from tests. Granting the limitations of the tests and the difficulty of their exact interpretation, which by the way, applies to all materials, no one would deny that great progress has been made by use of tests. In a general way, tests are used every day to determine properties of commercial metals.

If in two or more cases exactly the same grade of material is accorded the same or equivalent treatment, the altered materials will still be the same, one to another.

Test bars are castings of certain specified shape and dimensions. If castings and test bars all of the same analysis and cooling rate are poured at the same time from the same material, we would expect to find similar metal in each. The problems encountered are: (1) to make test bars whose cooling rates are like those of the castings; and (2) to use common sense in making allowance for peculiarities in design and foundry practice—particularly those which may promote shrinkage or other defects and those which call for slow or fast pouring of castings.

These points are borne out because the foundrymen of wide experience can take an analysis and a result on one of the so-called arbitration test bars and many times predict quite closely what the iron in the casting will be like.

It then is possible to solve our second problem—relationship of test results to the properties of the iron in the casting. What is needed is co-operation in accumulation and interpretation of sufficient data. Careful study must be made of test methods. In the correlation shown in the examples given previously, the general agreement becomes more remarkable when it is considered that the metal flow in the castings may be slower than in the bar, and that the machined tensile bar is in case of the castings closer to the cooling surfaces than in the tensile bars—thus neglecting the well known and demonstrated differences due to cooling gradients of unlike sections of similar volume to surface area relationship. This is most apparent in larger sections.

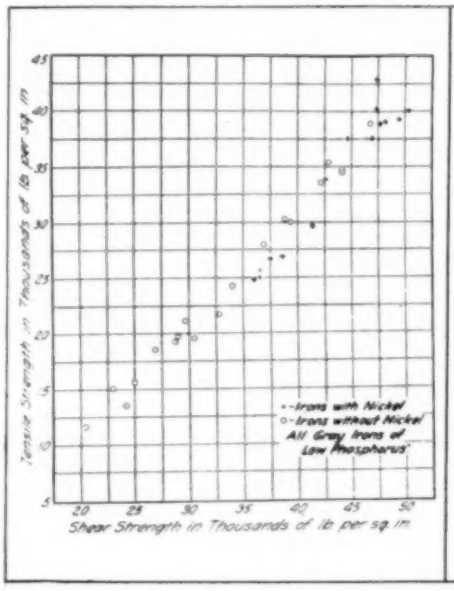
Our experiments show that if we take irons of given analyses, made by the same process, and otherwise duplicating the four factors of chemical composition, structural makeup of the charge, melting process and thermal history which have been mentioned previously, the irons naturally will have similar properties. On a day's operation when castings and test bars are poured simultaneously, the first three factors are in duplicate. To obtain bars which represent iron in the castings, we must choose those which have like cooling rates (thermal history). This we have shown is possible, when we are trying to obtain data representing properties of castings of simple shapes, either by getting comparatively cooling rates by thermocouples, or easier and accurately as this article shows, by mathematical computation. Fig. 6 is the key to this important conclusion.

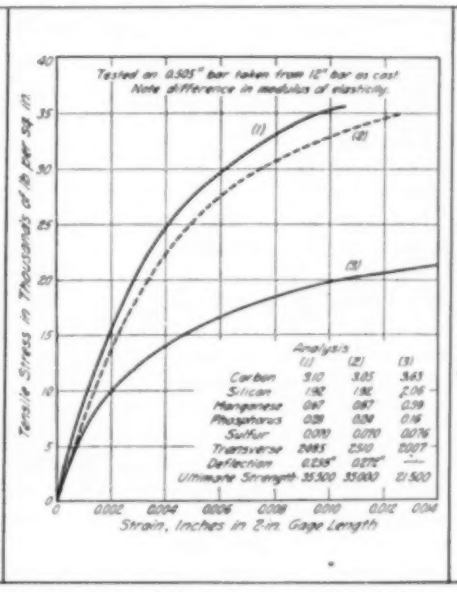
The usual commercial impracticability of the French scheme of trepanning a small shear sample from actual castings appears a barrier to widespread use of this method. In America attempts to get similar tests into specifications for steel castings have been opposed. There may be some merit in the idea of cast-on bars for certain types of casting. The work of the late George K. Elliott, Willard Rother, and the author demonstrate certain objectionable features in the original Fremont test.

This test, as proposed, was hardly precise enough for use in commercial specifications. The machine did not seem sufficiently rigid and the method of preparation of the test bar by a hollow drill is open to criticism. Accurately machined bars are an absolute necessity, and a rigid and accurate machine is needed. The test piece proposed was too small to be representative of the general properties of the iron. On the other hand, the basic idea of the French engineers is good. With proper modification, the shear test is quite useful in research work.

Transactions of various American associations contain many discussions

(*Concluded on Page* 583)


Tensile Strength in Thousands of lb per sq in
Shear Strength in Thousands of lb per sq in
--Irons with Nickel
o-Irons without Nickel
All Gray Irons of Low Phosphorus


Tested on 0.505" bar taken from 12" bar as cast
Note difference in modulus of elasticity
Tensile Stress in Thousands of lb per sq in
Strain, Inches in 2 in. Gage Length
Analysis
(1) (2) (3)
Carbon 3.10 3.05 3.63
Silicon 1.92 1.92 2.06
Manganese 0.67 0.67 0.59
Phosphorus 0.28 0.04 0.16
Sulfur 0.070 0.070 0.076
Transverse 2485 2510 0.027
Deflection 0.238" 0.276" —
Ultimate Strength 35500 35000 21500

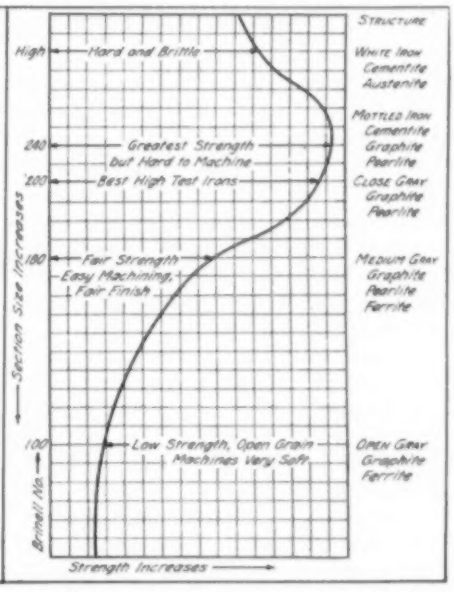


FIG. 9—RELATION OF TENSILE STRENGTH TO SHEAR STRENGTH. FIG. 10—RELATION OF TENSILE STRENGTH TO STRAIN OF DIFFERENT CAST IRONS. FIG. 11—DIAGRAM SHOWING QUALITATIVE RELATION OF SECTION SIZE AND TENSILE STRENGTH IN CAST IRONS OF DIFFERENT STRUCTURES

Bill Describes Mold for Hydraulic Cylinder

By Pat Dwyer

AT THE last and greatest show down, when the final picture (see works of R. Kipling, esq.) is painted with the sweep of a comet's tail, makers, owners and—Ahem—part owners of automobiles will have a heavy score to settle for practically ruining boyhood's greatest and most thrilling pageant, the annual circus day parade.

Headed by the steam calliope—grandest of all musical instruments and known to the proletariat as the *callyoap* with the *o* sound as in cope, dope, soap and nope—the parade moved majestically in a long and glittering line from the circus ground, through the business district of the town and back to the point of departure.

The grownup and more sedate portion of the community lined the sidewalks and was content to contemplate calmly the moving procession. Blase and sophisticated gentlemen confided to their immediate neighbors that there ain't nothin' to it. Once you seen one, you seen 'em all. They fondly imagined that the remark was original, calmly ignoring the fact that it has been employed by millions of men since a hard boiled old sergeant of the Legion first slipped it contemptuously from the corner of his mouth while standing at parade rest in the Colosseum in the days of Nero. Yeah, you know, the fiddling guy, and amateur fireman, de luxe. There was a lad who put on a show as *was* a show. He packed 'em in for afternoon and evening performance and had the S.R.O. sign hung out an hour before the big doings commenced. Lions and tigers crept stealthily around the sanded arena, nipping large painful bites out of each other. Stalwart gladiators stalked hither and yon, nonchalantly sticking their swords in any moving object on two legs or four. After each particularly effective bit of sticking they wiped their blades on the fur of the recumbent foe and then posed gracefully, sword point resting on the left bicep, to receive the applause of the multitude.

Alas and likewise alack-a-day, these good old days are no more. The snorting chariots of a pleasure loving and commercial nation on wheels have choked the city streets to such an extent that even the living skeleton could not negotiate the parade route. What chance then is there for the steam calliope, for the largest herd of mammoth pachyderms at present in captivity, for the 102—count 'em—102 perfectly matched Arabian steeds with their matchless riders, for the long line of gilded wagons containing the blood sweating Behemoth and other rare and fee-rocious animals collected at a tremendous outpouring of blood and treasure from the most remote corners of this terrestrial globe, for the blaring band in gaudy and tinseled uniform, for the splay footed camels, Lay-deez an' Gents, the well known ships of the desert that can walk seven days for a drink, for the Indians, cowboys, buffaloes, ostriches and the Sacred Cow from the banks of the Ganges, procured at vast expense and subsisting solely on a diet of arrow root and wild honey.

What chance, indeed, says you. Just about the same chance the well known camel had to wiggle his big, flat feet, his hump and his ungainly body through the eye of the needle.

I happened to quote this familiar comparison to Bill the other night and he promptly proceeded to show me the argument was worthless.

"When the statement first was made" Bill said "it probably was a knockout, but civilization has made vast strides since these early days. If the plaintiff in a modern case claimed that a certain act was as difficult or as impossible as driving a camel through the eye of a needle, the defense would knock him silly. The chief counsel for the defendant would not bother his head with it. He would languidly turn the case over to the third assistant to his first helper. That dapper young gentleman would telephone the local steel plant to make him a special needle, with an eye 3 x 9 feet. On the day of the trial this would be set up as Exhibit *A*. The jury would be asked to note carefully that not only one, but, if necessary, a string of camels half a mile in length could be driven through in perfect safety and comfort. If necessary he would borrow a camel and push him through. The law is a wonderful thing." This reference to camels reminded Bill that the circus was showing at the usual place on the morrow. He regretted, as I did, that we no longer could view the parade and thus secure the preliminary thrill, but so far as he could see, no

THE LABORER IS WORTHY OF HIRE

valid reason existed to prevent us from attending the show.

We arrived in ample time to make the grand tour of the menagerie and side show before the performance began under the big top. Pausing in front of the orang-outang's cage I directed Bill's attention to the wonderful resemblance the inmate bore to a one time *gay cat* known as Dutch Charlie.

Bill ostentatiously drew a paper of *mail pouch* from his hip pocket. Holding the package firmly in his left hand he inserted the thumb, first, second and third fingers of the right hand and extracted the correct amount of tobacco specified in Article 3, Section 5 *The Molder's Guide*. With a sweeping and graceful gesture of the right hand and arm he deposited the chew in his left cheek and then returned the package to his pocket. The big ape in the cage showed not the slightest interest. "That big hairy bum looks like Dutch" Bill said "but its not him. If it was he would have had both hands out through the bars begging for a chew. That fella would beg a chew from the angel Gabriel the first time he met him. I'll never forget the day me and him and Slim McGonigle was pouring a big job. The cranky ladle jumped and spilled a couple of hundred pounds of metal over Slim's feet. Dutch and I carried Slim into the first aid room where Dutch kept up a running fire of sympathetic remarks while the doctor worked over Slim's feet. When the job was finished the doctor thanked us and intimated that our services no longer were needed. I started to leave the room, but Dutch lingered.

" 'Say Doc' he says 'ya ain't got a chew o' tobacco on ya anywheres, have ya? Me noives is all shot!' "

In the side show we saw further evidence of the blighting influence of civilization. To the pulsing rhythm of a jungle drum, a savage black cannibal chief, freshly imported from Borneo and marvelously tattooed, danced the war dance of his people in a manner that absolutely was terrifying in its horror and intensity. I made a mental note to cross Borneo off the list of places I want to visit.

After the crowd had moved away Bill nudged me to look back. May I be teetotally dandified if there was not the personification of death and destruction squatting on his hunkers calmly puffing a cigaret!

Ah! Civilization, civilization, what crimes are committed in thy name!

Fortified with a generous supply of pop and peanuts, we viewed the big show from a favorable position and were graciously pleased to admit that it was fully up to former standards. With the orgy of spending in full flow we cheerfully squandered another quarter for the pleasure of attending the concert after the big show.

The principal attraction at this after piece was a wrestling match between the circus strong man and any local champion who might feel impelled to uphold the reputation of our fair city. The management placed such implicit faith and confidence in its hitherto undefeated champion wrestler that it was prepared to pay

A GOOD TIME WAS HAD BY ALL

$100—One Hun-dred Dollahs—here it is folks—look at it—to any person who could pin him to the mat.

"That's a pretty safe bet" said Bill as he viewed the herculean wrestler. "That baby'l just eat 'em up."

Apparently several members of the audience held strong opinion to the contrary. Loud cries of "Bull" "Bool" "Bool Komar" "Oh, you Bool" "Come on you keed Bool" "Flatten him out Bool" resounded on all sides.

The Bool evidently had some inkling in advance. He arose in his place, shed a voluminous bath robe and stalked majestically to the mat. He nodded curtly to acknowledge the heartening cries of his supporters and then turned to the serious work in hand.

The two men were evenly matched. In a neutral atmosphere they might have remained locked in a death grip forever without either one gaining an advantage. This was not a neutral atmosphere. The Bool's friends were there in considerable numbers and what they lacked in numbers they made up in noise. In a proper sporting spirit they wanted the better man to win, but they entertained a singularly unanimous opinion on which was the better man. They tendered advice and encouragement freely ranging all the way from the conventional "Attaboy Bool" to the impassioned plea "Break de naik! Qveek!"

A man must be less than human to ignore such touching expressions of confidence. The Bool grabbed one of his opponent's bare feet and twisted it to such an agonizing angle that the owner was forced to relax his grip. With a last mighty heave the Bool forced his adversary into a position where both shoulders touched the mat and the tussle was over.

I asked Bill if he was satisfied with the result.

"Well," said he, "I'll tell you. There's tricks in all trades, even in rasslin' where a man needs something besides main strength and agility. A condition often turns up in a foundry where a man is familiar with different methods of doing a job, but is forced by circumstances to adopt one when he might prefer another. An instance of that kind appeared the other day when I had a letter from a man who said he was enclosing a sketch of a hydraulic cylinder 10½ inches inside diameter, 1¼ inches metal thickness and 113 inches in length, with a box frame extending approximately half the length to serve as an anchoring medium. The pattern was split through the center longitudinally and he was undecided whether to pour the job horizontally or vertically. He had an order for only one casting, therefore hesitated at the expense of making an iron flask. He wanted to know if I thought it possible to make a casting of this kind horizontally to withstand a pressure of 750 pounds per square inch. Also would chills in the cope be of assistance. He intended to pour the casting from a mixture made up of 30 per cent steel scrap, 50 per cent pig iron (silicon 2.50 per cent) and the remainder machinery scrap. If he decided to pour the casting on end he asked if I favored pop gates or a gate extending to the bottom with inlets spaced approximately 12 inches apart from the bottom to the top. Which did I think the more suitable core for a casting of this kind, a loam core or a gravel core.

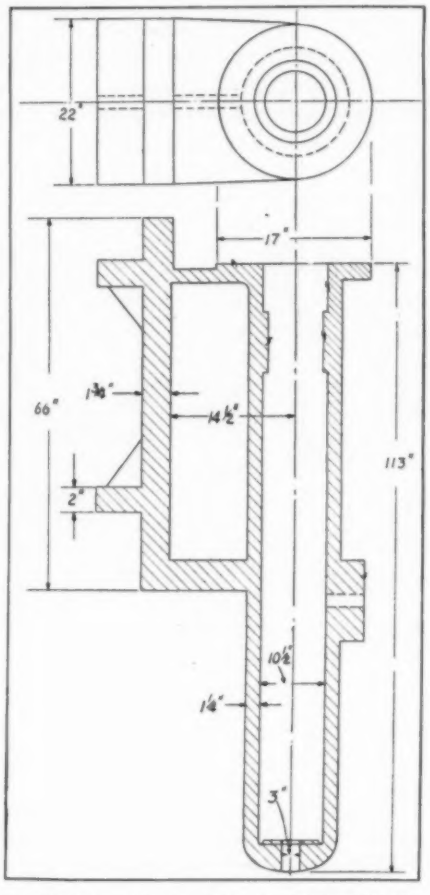
Under favorable conditions and in the hands of a highly skilled molder, this casting may be molded and poured

successfully in a horizontal position, either with one half bedded in the floor, or, with the lower half in a drag. The essential requisites are a mold and core that will not cause the metal to *flutter*, sand through which the gas can escape readily, hot iron to fill the mold rapidly and clean runner and gates. The majority of leaks in castings of this kind are caused by steam and dirt and these in turn are caused by a mold or core against which the metal will not lie quietly. This feature cannot be stressed too strongly, that is the necessity of producing a mold in which the iron will lie without a quiver.

The following brief outline covers the essential points to be observed. If the pattern is bedded in the floor a small cinder bed is placed under the box part. The sand is rodded and the pockets are vented generously. Chaplets present a certain amount of hazard, therefore they are omitted in the drag part of the mold. A good, stiff core supported firmly at each end will not sag to any appreciable extent. However, it should be tested with a straight edge while resting on two supports corresponding to the core prints and if it shows a sag, a single chaplet in the center will support it. Two chaplets about 3 feet apart will be required on the cope side to prevent the core from bending upward under the pressure of the molten metal. The chaplets should be tinned to prevent the metal from *kicking*, also to insure an amalgamation with the surrounding iron. Chaplets of any kind introduce a hazard into any casting that has to withstand high pressure. They must be handled with extreme care and intelligence. In fact the possibility of pouring castings on end without *any* chaplets constitutes the principal argument in favor of that method.

As a precautionary measure the gates should be located on the box frame and not on the barrel of the cylinder. Occasionally a small quantity of foreign material finds its way through, or is formed in the runner and gates. If the metal enters directly into the barrel, this material may lodge at a point that later will develop a leak. Entering first through the brackets of the frame, it may be arrested at some point where its presence is of no consequence. A single runner basin on top of the cope will deliver metal through an upright runner to a long gate cut in the joint and attached to the mold at two points approximately 5 feet apart. Dummy risers at these two points should catch any floating dirt. Needless to say the greatest care must be exercised in making a clean pouring basin. In this particular instance it may be advisable to blackwash and dry it. The mold, also, should be blackwashed and skin dried. A riser at each end and one on the foundation flange supplemented by a high pouring head will insure a solid casting.

A loam core swept on a suitable barrel usually is more symmetrical than a sand core made in halves and pasted. It insures a more uniform thickness of metal, it is easier to handle, it requires less material, it is dried more readily and for these reasons it usually is preferred in foundries where the proper facilities are provided for its construction. However, a sand core if properly made, rodded and vented will serve satisfactorily. The core for this casting should be made from a coarse sharp sand bonded with a minimum amount of binder and with a vent channel at least 3 inches in diameter in the center. A row of chills in the cope or on the upper side of the core will produce a denser structure in the metal in that area, but chills are not actually necessary with the mixture he proposes pouring into a casting 1¼-inches in thickness.



SECTION AND PLAN OF HYDRAULIC CYLINDER

Since he objects (quite reasonably) to the expense of making a special iron flask for this one job, it is quite pertinent to point out that in many instances it is advisable and in some instances it is quite obligatory to make castings of this kind in dry sand molds, in iron flasks and to pour them on end. Practically all the hazard is removed from the operation and good castings may be secured from men without any particular foundry skill or training. Even where the men are highly skilled, the practically positive insurance offered by this method results in its extensive adoption among foundries.

A third method also is available whereby this casting may be made in dry sand and poured on end without incurring the expense of a flask. Place the two halves of the pattern on an open sand bed and mark their outlines. Then remove them and make molds for two arbors with suitable dabbers extending down around the outside and in the pockets. Mount each half pattern on a board or plate and place a wood frame around it, thus converting the outfit into a corebox. Proceed then as in ordinary coremaking practice to make a half core with the arbor for reinforcement. The entire outfit is rolled over and the half pattern is removed. The two half cores are dried and then matched by the openings at each end. The center core is placed in position and then the two half cores are clamped together and either lowered into a pit or placed inside a suitable stack of iron flasks. Sand is rammed around the cores to hold them firmly in place and to prevent a runout.

The upper end of the center core is held in place with a number of wedges until the mold has been up-ended. The wedges then are removed and a ring core is lowered into place. The ring core is pierced with a number of small pop gates and a dry sand basin is utilized to receive the metal from the ladle as in pipe foundry practice. For pressure purpose the upper flange of the casting is extended upward from 4 to 6 inches. This head metal containing any sullage that may float to the top, is cut off afterward in the machine shop.

Describes X-ray Uses

Recently, the Eastman Kodak Co., Rochester, N. Y., published a 60-page booklet describing the uses of the X-ray in industry. Topics covered are industrial application, theory of radiograph, electrical equipment, accessory apparatus, making the radiograph, development of the radiograph, viewing the negative, the darkroom, and a bibliograph of literature on X-rays. Numerous illustrations aid the reader in following the text.

The FOUNDRY Family Photograph Album

Upper Left

B. J. BEHNEMAN

Joshua Hendy Iron Works, San Francisco

Lower Left

T. W. JEACOCK

Buffalo Bronze Die Casting Corp., Buffalo

Upper Right

S. S. PARSONS

New Haven Sand Blast Co., Cleveland

Lower Right

E. S. MONCRIEF

Henry Furnace & Foundry Co., Cleveland

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

ALUMINUM BRONZE DATA

(*Continued from Data Sheet No.* 770)

Cause and Remedy

Causes of the previously mentioned defects and their remedies are as follows:

(a) Whitish oxide inclusions are due to aluminum oxide formed during the alloying process. This oxide is not brought in with the aluminum ingot, but is due primarily to the presence of oxides of copper which are reduced by the aluminum. The alumina thus formed has a melting point of approximately 2050 degrees Cent. (3722 degrees Fahr.) and a strong propensity for remaining entangled in the melt.

(b) Pinholes are due largely to the tendency of both aluminum and copper to absorb gases into solution when molten; possibly hydrogen. The gas tends to come out of solution while the metal is solidifying. If solidification is sufficiently rapid, as in the case of die-castings, dissolved gases are retained in solution and there will be no pinholes. If cooling is

(*Continued on Data Sheet No.* 772)

Table IV

FATIGUE OF ALUMINUM BRONZE*

Material and Treatment

Material	Mn %	Al %	Cu %	Fe %	Zn %	Sn %	Heat-treatment
Mn-bronze, cast	0.20	0.23	56.85	1.50	Remainder	0.32	Tested as received.
All-bronze, extruded	....	10.06	89.81	0.13	....	....	Heat to 1650° F. Quench water. Reheat to 1150° F. Hold 30 min. Cool in furnace.
All-bronze, cast	....	9.78	90.22	....	....	....	Tested as received.
All-bronze cast	....	9.78	90.22	....	....	....	Heat to 1650° F. Quench water. Reheat to 1200° F. Hold 30 min. Cool in furnace.

Results Obtained

Material	Prop. Elastic Limit lbs. per sq. inch	Ultimate Strength lbs. per sq. inch	Elongation in 2 in. %	Reduction in area %	Brinell	Endurance Limit Rotating beam lbs. per sq. inch	Investigator
†Mn-bronze cast	13,000	70,000	32.8	40.8	93	17,000	R. R. Moore
All-bronze extruded	16,900	77,000	35.5	34.0	128	34,000	R. R. Moore
All-bronze cast	5,100	59,300	20.0	28.1	96	22,000	R. R. Moore
All-bronze cast	24,900	77,800	14.0	19.0	192	26,000	R. R. Moore

*Reprinted, by permission, from "The Fatigue of Metals," by H. F. Moore and J. B. Kommers (McGraw-Hill Book Co., New York).

†On a 100 million reversals basis (Moore, R. R.—*Proc.* American Society Testings Materials June, 1923).

ALUMINUM BRONZE DATA

(*Continued from Data Sheet No.* 771)

slow, gases not only come out of solution but have time to leave the melt. The rate of cooling of the average commercial sand casting, however, falls neatly between these two extremes. Gas is liberated just in time to be caught in the solidifying casting, showing up in the well-known pinholed structure.

Now since both of these defects initially are associated with the alloying and melting, their remedies will be dealt with under that heading.

Melting Practice

To avoid drossy patches, avoid first the presence of copper oxide. The best way of insuring this is to use only electrolytic copper, which is not only free of oxide, but is also free of arsenic, antimony, etc., which might affect the physical properties of the casting. The next best way is to deoxidize copper thoroughly before introducing the aluminum, rather than allow the latter to act as deoxidizer.

To do this, first melt the copper to the desired fluidity under a good layer of charcoal, and then add either 0.25 per cent silicon-copper or 0.1 to 0.2 per cent manganese. Stir gently from the bottom up without undue disturbance of the surface. Skim thoroughly, and add the aluminum in the form of stick to the required percentage. The temperature will rise on the

(*Continued on Data Sheet No.* 773)

Table V

SPECIFICATION VALUES FOR ALUMINUM BRONZE

United States Naval Dept.

Composition

Cu	Fe	Al	Sn	Impurities (Pb, Zn, etc.)
85-87	4.5-2.5	7.0	0.5 max.	0.1 max.

Material	Yield Point lbs. per sq. inch	Tensile Strength lbs./sq. inch	Elongation % in 2 in.
Ingots		75,000	30
Castings		70,000	25
Rods and Bars (to ½ inch)	40,000	80,000	30
Rods and Bars (over ½ to 1 inch)	37,500	75,000	30
Rods and Bars (over 1 inch)	35,000	72,000	30
Shapes	37,500	75,000	30
Sheets and Plates (to ½ and to 30 inches wide)	40,000	80,000	30
Sheets and Plates (to ½ and over 30 inches wide)	39,000	78,000	30
Sheets and Plates (over ½ inch)	37,500	75,000	30

All wrought material required to bend 120 degrees around a radius equal to its diameter or thickness, without sign of fracture.

Reprinted by courtesy of Jerome Strauss.

Melting Iron in the Cupola

By J.E.Hurst

Part XXI

IN PRACTICE the clean borings are sprinkled with the requisite quantity of binder in solution or in suspension in water. This is the method followed with sodium silicate, calcium or ammonium chlorides, clay wash and lime water. The sprinkled borings are mixed thoroughly and wetted all over, then turned over with a shovel or in a mechanical mixer. Lime, magnesite, cement or other dry powder is intermingled thoroughly with the borings and the chloride solutions or water added subsequently, as in concrete making.

Borings, thoroughly wetted with the binder, are formed into briquets by ramming them in molds of a suitable shape with regular foundry rammers, as in ordinary molding practice.

Briquets also may be formed in a small hand, hydraulic or pneumatically operated press head type of molding machine. The briquets are transferred to a stove for drying and hardening. In the green condition they are weak and require careful handling. Usually they are handled on steel or cast-iron plates, as in ordinary core room practice.

An initial tempering period before final drying and hardening is distinctly advantageous in improving the strength both in the green state and in the dried state. If the wetted briquets are allowed to stand, the temperature rises in accordance with the size, to a point where in many instances steam appears. Sodium silicate, cement, clay wash and mixtures of lime and calcium chloride are natural bonding materials. Merely as a briqueting and bonding agent sodium silicate probably is the best, and is only objectionable on the ground of cost.

The writer has made extremely hard briquets, using a 10 per cent solution of commercial sodium silicate in water. The rectangular bricks, 4 x 6 x 12 inches, with rounded corners were rammed on a hand-operated, press head, molding machine. They were dried in a core stove, were capable of a considerable amount of rough handling, and withstood perfectly the action of charging into the cupola. A 5 per cent solution gave a weaker briquet, but one that could be handled with sufficient care. Strength of the briquet was improved considerably by allowing an ageing period before drying.

Bonding properties due to the ordinary process of rusting when borings are exposed to the weather, are well known to most foundrymen. Boring piles exposed to weather conditions for a prolonged period, rust together on the exposed portions of the pile, and often develop a hard skin almost impenetrable to a pickaxe.

Superficial oxidation or rusting of the individual borings forms a solid mass of partially-oxidized iron. Probably much of the bond obtained by the use of water solutions, suspensions or mixtures of even natural bonding materials is obtained through the superficial rusting of the borings. Sal-ammoniac and calcium chloride act simply as rusting agents. Their effective action is slow in making a really hard briquet. On this account these bonding materials, accelerators of the natural process of bonding by rusting, involve a considerable amount of handling, also space for stocking and ageing. Effect of tempering or ageing on the strength of briquets before drying undoubtedly is to be ascribed to the rusting action set up by the addition of water. Rise in temperature of the briquets from the oxidation reactions is sufficient evidence of this. In all briquetting processes where wetted borings are used, the strength of the briquets is increased materially by ageing.

Power pressing overcomes the difficulties occasioned by handling the briquets in the green state, and also speeds production. A variety of power presses are available for this purpose. The presses generally are operated hydraulically by rams or by toggle levers operated through direct motor drives or from line shafting. Pres-

Melt Borings

BORINGS are sprinkled with any one of a varied list of binding materials including sodium silicate, calcium or ammonium chlorides, clay wash and lime water. In some instances lime, magnesite or cement is added first in powdered form. Where the quantity is small the briquets are rammed by hand in a suitable frame. In larger quantities a pressing machine actuated by steam, air, oil or water is employed. In some of the largest installations a hydraulic press has been developed for the purpose. Under a pressure of several hundred tons the borings are reduced to compact disks without the aid of any binder. A loss of about 0.15 per cent silicon can be expected for every 10 per cent briquets added to the charge in addition to the usual loss due to remelting. This is the concluding installment in the series of articles on "Melting Iron in the Cupola" by Mr. Hurst.

sures up to 30 to 40 tons per square inch are utilized on many of these presses. High initial cost of heavy machinery has militated against its more extensive adoption for briquetting cast-iron borings.

A smaller type of briqueting press, 4½ horsepower, has been designed to operate on compressed air of 90 to 100 pounds per square inch pressure or to operate from a direct belt drive. Approximate weight of the whole press is 1½ tons. It is of the knee-joint type with extractor mechanism for ejecting the briquets from the dies. Addition to the borings of 5 per cent slaked lime and 5 per cent water is recommended in using this machine. The resulting briquets are placed on drying trays and allowed to remain for an initial hardening period. They are not dried in an oven. The briquets are allowed to stand for three or four weeks in the open air for final hardening. A sprinkle of water is recommended in dry weather, but too much moisture hardens the skin only, and prevents any further hardening of the inner portions. Well-tempered briquets can stand all kinds of weather and are sufficiently hard for transport. It is stated that presence of slaked lime protects the briquets from excessive rusting due to exposure.

Multiple Briquet Mold

System in operation at the works of Glenfield & Kennedy Ltd., Kilmarnock, Scotland, employs a special type of hydraulic press. Three briquet molds may be rotated in turn to a position underneath a hopper and there filled with borings. The filled mold is rotated further and locked in position opposite a hydraulic ram. The second mold then is in position ready to be filled, and by an ingenious arrangement the briquet which can be imagined as existing in mold three, is ejected as a result of pressure applied to mold one. The taper tube molds produce a briquet 3.5 inches in diameter at one end, 3.25 inches at the narrow end and with an overall length of 6.5 inches. The taper tube has an initial length of 13.5 inches. Pressure of 35 tons applied to the wide end of the mass of borings reduces the length of the briquet to 6.5 inches.

In this system the borings are mixed with clay wash the consistency of thick cream. Clay content of the final briquet varies from about 5 to 7 per cent. The briquets are allowed to rest for two or three hours for primary hardening. After this initial hardening period they are given a final drying in the core stove for about 13 hours. With care the briquets can be handled in the green condition. When dried they can be dropped onto hard material from a height of 20 feet without disintegration.

A briqueting machine built by the Southwark Foundry & Machine Co., Philadelphia, and installed at the plant of Dodge Bros., Detroit, utilizes mechanical and hydraulic pressure. Power is applied first through a motor and crank and after partial compression mechanically, hydraulic pressure of 20 tons per square inch is applied. Briquets 4 inches in diameter, 3 to 4 inches long and weighing 7 pounds each are produced at the rate of 50 tons per 24-hour day.

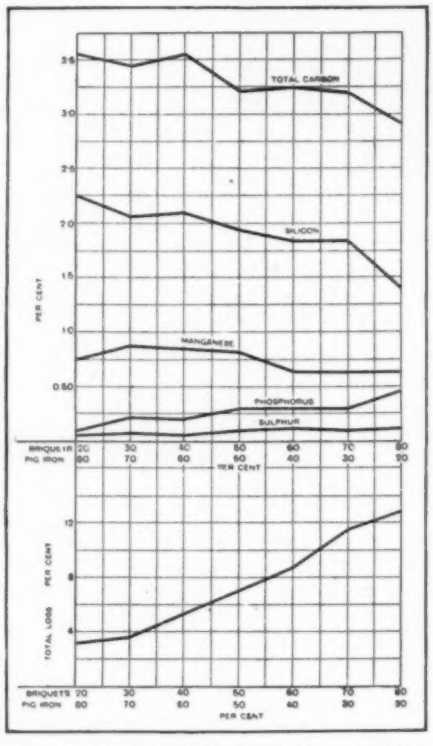


FIG. 128—LOSS AND VARIATION IN CHEMICAL COMPOSITION OF CUPOLA MELTED IRON CONTAINING BRIQUETS

In the DeGama process equal pressure is applied on each side of the briquet in a progressive and uniform manner, until a final pressure of approximately 70 tons per square inch is attained. By a shaking arrangement the air bubbles are eliminated completely from the briquet. Some years ago a company started a plant in Cincinnati operating at 50 tons pressure per square inch and producing 5 tons of briquets per hour. A loss of 8 per cent was experienced on remelting an all briquet charge and 4 per cent only on remelting a charge of 80 per cent pig iron and 20 per cent briquet.

All masses of borings contain some fine-grade material and some of coarser grades which are unevenly distributed in the dry state. Application of liquid binder probably promotes more even distribution of the fine and coarse grades in the mixing operations.

Effect of the relative proportion of fine and coarse grades of borings on the mechanical strength and hardness of the briquet often is ignored. Borings containing a higher proportion of fine grades generally form a stronger and harder briquet. This effect is more pronounced in briquets formed by heavy pressures. Fine grades fill the interstices between the coarser grains and provide a large contact surface for the bonding material. In many instances more satisfactory results are obtained subjecting the coarse grades to a preliminary crushing operation. This operation can be carried on conveniently in an ordinary edge runner pan, or mortar mill. Bonding material can be added and thorough mixing assured at the same time.

Viewed With Suspicion

Utilization of briqueted borings in the cupola mixture still is regarded by many foundrymen with a certain amount of disfavor. This attitude generally accompanies any attempt to utilize materials which have been regarded as waste or scrap. Needless to say this disfavor is unjustifiable. When briquets are used properly, no inferior results follow. Various published experiences on the use of briquets show that the addition of briquets to gray iron mixtures increases the mechanical strength.

Extensive experiments of Fichtner admirably illustrate the influence of remelting various proportions of briquets in the cupola charge. Varying proportions of briquets were added to successive charges of hematite pig and a final charge consisting wholly of briqueted borings also was melted in a cupola. The general conclusion drawn from these experiments was that up to a proportion of 30 per cent briquets in the charge, no great loss was experienced, but the loss steadily increased with increasing proportions of briquets up to 100 per cent. The analytical results graphically are illustrated in the upper part of Fig. 128. Increase shown in phosphorus and sulphur is due entirely to the composition of the briqueted material. Apart from these constituents the figures show a steady fall in the silicon content with increasing quantities of briquets. The manganese shows little change, and the total carbon falls rapidly with proportions of briquets in excess of 50 per cent.

Silicon loss is confirmed by other investigators. With 25 per cent bri-

quets the silicon was found to drop from 1.96 per cent to 1.63 per cent in certain experiments made in the Sulzer foundries, Switzerland. Under the same conditions, no change in manganese was noted, and the total carbon loss was from 3.00 to 2.75 per cent, a loss of 0.25 per cent.

In melting a charge of 1500 pounds consisting solely of briqueted borings, containing approximately 2 per cent silicon, Gardiner obtained a white iron indicating an extensive loss in silicon content. A charge of 50 per cent briquets with pig iron and scrap also was found to lose approximately 1 per cent silicon in the process of remelting.

These silicon losses are precisely what would be expected. The briqueted borings were mixed with a wet binder, and were rusted extensively. Silicon loss was brought about by the presence of this rust. The same effect may be observed when melting rusty iron scrap. For this reason, due allowance must be made in calculating the proportions of any mixture containing briquets.

Gives Melting Losses

Extent of allowance to be made when using any given quantity of briquets will depend wholly on the character of the briquets. Where briquets are excessively rusted, the allowance will be greater, and in all cases should be determined by direct experiment. As an approximate guide, a loss of about 0.15 per cent silicon can be expected for every 10 per cent briquets added, in addition to the normal loss due to remelting. Silicon loss shows the necessity for initially higher silicon content in the pig iron or scrap iron proportion of the charge when using briquets, to preserve the same conditions as obtained in the absence of briquets.

Total loss in remelting briquets is of considerable interest in figuring economies arising from their use. In making such estimates, due regard always should be paid to the amount of material added to briquets as binder. Total losses in the experiments of Fichtner, are illustrated graphically in the lower part of Fig. 128. The total loss with 30 per cent briquets in the charge amounted to approximately 4 per cent, and this was found to steadily increase with an increase in the proportion of briquets in the charge. Murphy has recorded a loss of only 2 per cent and Gardiner experienced a loss of 11 per cent.

Adopts Standard Sales Agreement

GRAY Iron institute, Cleveland, recently announced the adoption of a standard sales agreement and a set of trade customs. The sales agreement and trade customs were prepared by the merchandising committee of the institute and have been approved by the board of directors of that organization.

The standard sales agreement which presents conditions and terms upon which all quotations are made, is as follows:

1. Unless otherwise agreed, quotations must be accepted and patterns furnished the foundry within thirty (30) days from date of quotation.

2. All castings are sold as rough castings, f.o.b. cars, foundry point. Terms—thirty (30) days net, from invoice date, unless otherwise stated.

3. Claims for error in weight or number must be made within five (5) days after the receipt of castings.

4. Foundry is responsible only to the extent of replacing castings rejected due to foundry defects and such castings must be reported or returned to the maker within ninety (90) days after their receipt.

5. Foundry is not responsible for machine work, labor charges or other losses or damages caused by defective castings.

6. Foundry is not responsible for loss of or damage to patterns by fire or other casualties beyond its control.

7. Foundry shall not be liable in damages for failure to deliver as a result of fires, strikes, differences with employes, accidents or other causes beyond its control.

The institute explains that the trade customs are presented to establish between the customer and the foundry a complete understanding of those conditions particular to the gray iron foundry business. The trade customs are as follows:

Quotations

1. Blue prints submitted for estimating purposes should be marked with rough casting weight, if known, or an estimated weight upon which quotation will be based. A detailed description of the pattern equipment should be furnished.

2. When quotations involve the making of piece prices, definite weights shall be established and agreed upon, and quotations shall be subject to revision on any variation from the established weights.

3. Unless otherwise specified by the foundry, quotations are based on castings with gates, fins and other projections removed to approximately the contour of the pattern.

Orders

4. No order shall be changed unless notice of revision is made and accepted in writing before work is in process. If work is in process, customer is to be charged for any castings made as well as cost of cores, molds or equipment discarded because of such changes.

5. Cancellations of orders are to be made only by mutual consent of buyer and seller.

6. Unless otherwise stipulated, the customer shall accept an overrun of ten per cent above quantities specified on order. However, the foundry is to make an effort at all times to furnish as near the exact quantity specified as operating conditions will permit.

7. If customer requires special production service to secure unusual deliveries, an extra charge shall be made.

8. Customer must supply equipment in condition to produce economically the quality and quantity of castings required.

9. An extra charge will be made if patterns require stopping off or if skeleton or sweep pattern equipment is furnished.

10. Foundry is not responsible for variations existing between blue prints and equipment supplied by customer.

11. All patterns, core boxes and loose pieces thereof, should be marked properly for identification.

12. Follow boards, core driers and similar devices when required, are to be furnished by customer.

13. Repairs and changes to patterns by customer's orders will be made at expense of customer.

14. All freight, drayage, boxing and crating charges of patterns, both to and from the foundry, shall be assumed by customer.

15. Pattern storage facilities are provided by foundry for active patterns only. Patterns not in use for a period of six (6) months will be returned to the owner or will be subject to storage charges.

Patterns and Core Box Equipment

To insure the elimination of error, the following recommendations, agreed to by other outstanding organizations of the foundry trade, are made.

Patterns are to be painted the following standard colors:

Unfinished surfaces—black.

Machined surfaces—red.

Seats of and for loose pieces—red stripes on yellow background.

Core prints and loose core print seats—yellow.

Stop-offs—diagonal black stripes on yellow base.

The institute has published a folder containing the sales agreement and trade customs.

Central Illinois Foundrymen's club, held its May meeting at the Pere Marquette hotel, Peoria, Ill., May 25. Twenty were present at the meeting which consisted of a luncheon followed by a business session.

Gas-fired Tunnel Kiln *Provides* Continuous Malleable Anneal

By J. B. Nealey

MALLEABLE iron castings, when first produced, are brittle white iron castings. Annealing is a heat treatment developed to convert this hard, white iron into the malleable casting of commerce. Several types of periodic furnaces were used for a great many years but some of them have been supplanted, in the larger foundries, by the continuous furnace using gas fuel.

Strength, toughness, ductility and machinability are the characteristics that must be brought out in malleable castings so that they may meet the requirements of commerce. This is accomplished by subjecting the castings to an annealing cycle that will break up the combined carbon into temper carbon and ferrite, for iron containing combined carbon is progressively harder and therefore increasingly costly to machine, as well as brittle.

Have High Tensile Strength

A good annealing practice has been worked out in the research laboratory of the National Malleable & Steel Castings Co., Cleveland. Castings produced by that company average 53,000 pounds per square inch tensile with an elongation of from 16 to 20 per cent in 2 inches. The cutting speeds in machining these castings average between 80 and 125 feet per minute. The firm produces a wide variety of malleable castings, but the bulk of production is for the automotive industry, and includes such parts as rear axle and differential housings, clutch parts, brake and foot pedals, hubs, spring seats, etc.

Annealing practice used consists of subjecting the castings to a carefully worked out heat gradient consisting of five steps. The castings are: (1) heated to maximum temperature (1600 degrees Fahr.), (2) maximum temperature is maintained until equilibrium is attained in the graphitization of the cementite, (3) cooling to critical point, (4) holding the temperature just under the critical point for an appreciable period and (5) further cooling to permit handling. The entire cycle occupies from 5 to 6 days.

In designing a furnace that would accommodate such a cycle, the continuous kiln type with a length of 350 feet was chosen. Capacity was also a controlling factor and as approximately 45 tons of castings would be charged daily, a width of 20 feet and a height of 15 feet were settled upon. This furnace is of brick construction, full muffle type and the work is pushed through on cars running on a track, and actuated by an hydraulic pusher. It was at first heated with oil but later changed to gas firing for physical, metallurgical and economic reasons.

Castings are packed in cast iron boxes or pots. These are set on cast iron stools with short legs and then other pots are placed on top until a stack about the height of the furnace, has been built up. The last pot is closed with a plate or fireclay. Pots are of the same material as the castings when first cast and are good for many trips through the furnace. Generally, no packing is used but if a packing is necessary to keep the castings from sagging, then a chemically inactive material is chosen.

Compartment Is Sealed

At each end of the furnace is a loading and unloading compartment respectively, sealed so as to prevent air leakage into the furnace. These compartments are not used as such at the present time. The stacks are made up on the cars laying on a track just outside the furnace and parallel to it. When a car is loaded, it is pulled up to the loading end by a tractor and pushed in. The pusher then advances it into the furnace, at the same time pushing the furnace charge along so that the last car in the row enters the unloading compartment from whence it is pulled by the same previously mentioned tractor.

The principal gas burners are located in the first half of the furnace. There are 8 on each side about 15 feet apart and they fire directly into fireclay muffles, one on each side and extending the entire length of the furnace. Gas burners are also available in the second half of the furnace for controlling the cooling rate but at present these are not necessary. The muffles form a continuous flue on each side of the furnace throughout the preheating and soaking zone with the off take flue located at the charging end of the furnace. This causes the hot combustion gases to flow in the opposite direction to the movement of the loaded cars, thus giving up the heat progressively to the incoming cold work. The furnace is set on a concrete foundation and the brick walls have 9 inches of powdered siliceous material between for insulation, while 12 inches of insulation is used in the crown.

Shorter Entrance End

It is usually the practice in tunnel furnaces to obtain a supply of preheated air for combustion from the cooling zone where it is heated in a counter-flow fashion by the outgoing loads. Due to the slow cooling rate necessary to obtain a satisfactory transformation of the combined carbon into temper carbon, practically no heat from the outgoing loads is available for use in the heating zone. In fact, at times, especially when on slow schedule, heat has to be supplied in the cooling zone to maintain the requisite cooling curve; the rate of heat loss through the arch being excessive in spite of its heavy insulation. For this reason it has been found desirable to shorten the furnace at the entrance end, remove the exhaust gases at a temperature of about 1000 degrees Fahr. and use them for preheating the combustion air to a temperature of approximately 550 to 600 degrees Fahr., in a re-

cuperator provided for that purpose.

Forty-one thermocouples protruding through the roof into the heating chamber are arranged in three long rows. They are connected to pyrometers and with these aids, the temperatures of the different zones are maintained. The tops of the cars are 6 feet wide and 4 feet long and consist of a single casting with sides, covered with fire brick and insulating material. A cast-iron plate, 1¼-inch thick, on top of this takes the wear of loading and unloading of the boxes or pots containing the castings.

The bottom of the furnace is flush with the car top and the trucks and wheels operate in a pit below. Steel strips on the sides of the car are utilized to keep the heat of the furnace from penetrating to this pit. Cold air also is circulated in this pit from a row of pipes arranged along both sides. Each car weighs 2 tons and carries 3 tons of castings and 4 tons of pots making a total weight of 9 tons. The furnace will hold 84 cars at a time.

In addition to the kiln, 13 periodic, gas-fired annealing furnaces are used in the plant. These furnaces are each 20 feet square and 15 feet high. They are built of brick with suitable insulation and have only one door consisting of a cast iron frame filled with brick. The pots are filled and stacked on a cast iron stool, which is then raised by a high lift truck and charged into the furnace. Each furnace will hold 60 stacks.

Three of these furnaces are of the muffle type, while 10 are fired directly. It requires four gas burners, two along each side, to heat one of these furnaces. Two thermocouples connected with an indicating pyrometer are used to control the temperatures in each furnace. Practically the same annealing cycle as that described is used in conjunction with the periodic gas furnaces. The heat gradient is obtained by limiting the flow of gas gradually.

Gives Test Bar Results

(*Concluded from Page* 575)

criticising attempts made to draw practical conclusions from crucible melted metals. However, it is well recognized that general metallurgical understanding is enhanced by such work, and that it is of decided ultimate value.

No silicon carbon summation results can be used as a short cut to complete knowledge of the expected properties of the metal. However, they are useful if applied with discretion. Some interesting relationships are implied in Figs. 2, 5, 8, 10 and 11. The same applies to attempts at correlation of brinell values to tensile and transverse strength—useful within limits, but no panacea.

The present trend of thought seems to be that control of amount and form of graphite is more important than control of matrix alone. A 2.70 per cent carbon iron with 0.60 per cent combined carbon possesses different properties than a 3.70 per cent carbon iron with 0.60 per cent combined carbon. However, neither factor can be ignored. The condition of the graphite undoubtedly is dependent on the nature of the carbide resulting from influences of both composition and thermal history.

The work of the United States bureau of standards sheds a great deal of light on the lack of seriousness of the gas problem as shown by Jordan, Eckman and Jominy, *Transactions*, A. F. A., 1925. The importance of this factor seems to have been exaggerated unduly in former years. This refers to dissolved gases, not to blowholes and incipient shrinkage in castings.

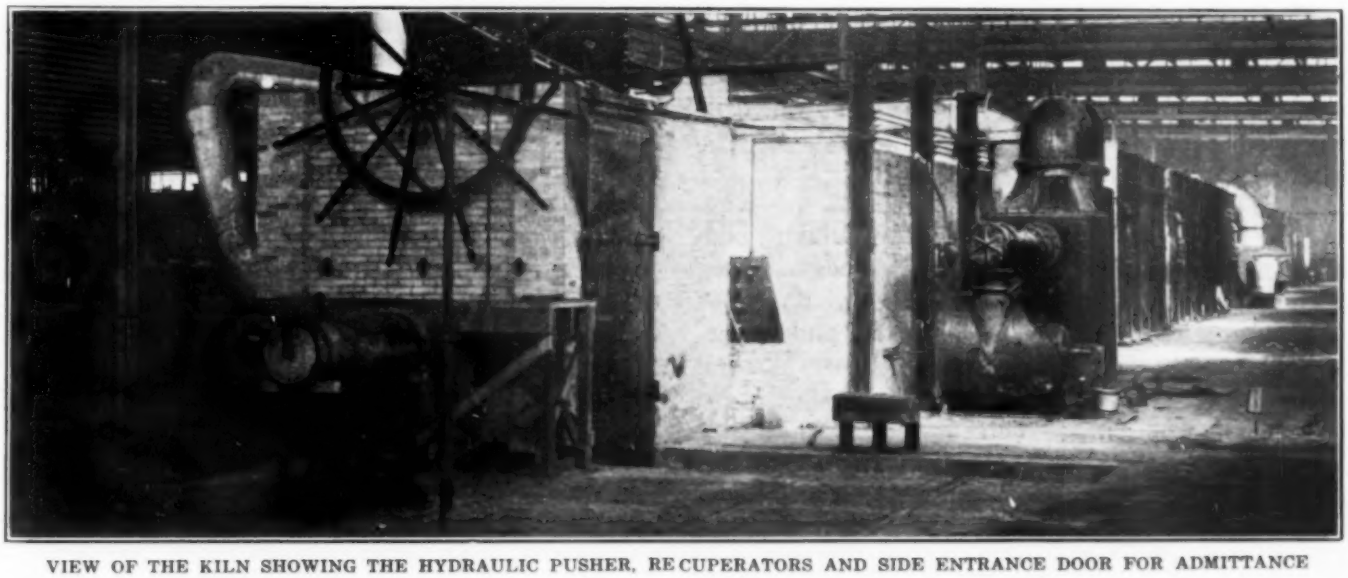
Ingotism is important, yet more recognized through inference than by direct reference. Macroscopic methods deserve more attention as previously mentioned in THE FOUNDRY, Aug. 15, 1924. Internal stresses are being recognized in the heat treating practices followed by many American firms. Results of an investigation on heat treatment of cast iron were presented by O. W. Potter in the *Transaction*, A. F. A., 1925.

Segregation Pays

The advisability of segregating different kinds of scrap materials in manufacturing plants and foundries is strikingly pointed out in methods in force at the Ford Motor Co., Detroit. Close to 150,000 pounds of special steels are used daily in reconditioning and replacing worn tools, dies and machine parts. By carefully segregating the scrap special steels and remelting them, their value is increased from $14 to $15 a ton as scrap material to the price of new material, and in the case of high speed steel, up to $1 a pound.

New England Group Meets

Planning as an aid to foundry management was the subject of discussion at the regular June meeting of the New England Foundrymen's association, held at the Exchange club, Boston, June 12. P. R. Ramp, superintendent, foundry and pattern shop, Newport News Shipbuilding & Dry Dock Co., Newport News, Va., was the principal speaker.



VIEW OF THE KILN SHOWING THE HYDRAULIC PUSHER, RECUPERATORS AND SIDE ENTRANCE DOOR FOR ADMITTANCE

The Shakeout

DAN M. AVEY, Editor
PAT DWYER, Engineering Editor
EDWIN BREMER, Metallurgical Editor
FRANK G. STEINEBACH, Managing Editor
CHARLES VICKERS, Nonferrous Editor
NORMAN F. HINDLE, Assistant Editor

¶ Find Time To Read

THE number is comparatively small when considered on a percentage basis of the total number of inquiries that pour into THE FOUNDRY offices, but still it is sufficient to show how some men hypnotize themselves into the belief that they are too busy to read. The term reading in this instance is confined to technical and business magazines and papers. In all probability these men find ample time to read the daily papers, maybe a few of the more popular magazines and a book or two occasionally. These various publications are read either through force of habit, or merely as a form of relaxation. Only a brave man will claim that they are either necessary or of any assistance in the daily struggle for existence.

NO PERSON will deny that a man has a perfect right to as much relaxation and pleasure as he can afford, while connected with the foundry business. At the same time, publishers of business and technical magazines make no claim that their publications are distributed for purpose of entertainment. They go to considerable effort to present material that will assist the reader in solving his daily problems, in easing the routine practice, in keeping abreast with developments in the industry and thus place him in a position to hold up his end with his competitors. Reading his business paper should be regarded as part of the regular routine. It is just as essential as any of the other complex factors that must be attended to in the production and sale of the various types of castings.

MEN who read THE FOUNDRY regularly, constantly add to their store of knowledge. They find information on practically every phase of the casting industry in the editorial and advertising pages. The careless few either do not read, or, skip hurriedly through the pages. No impression remains in their minds of what they have just read. When a question arises on some disputed point, or they want the address of a manufacturer of supplies or equipment they are put to the inconvenience of writing a letter and of waiting two, three or a greater number of days for information that already has been in their hands not once but perhaps many times without their realization.

¶ Stabilizing the Industry

SINCE the first of the year manufacturing establishments throughout the country have been exceptionally active, and production records have been established in several lines. The automobile industry undoubtedly has been responsible for a healthy condition in various feeders which supply raw, semifinished and finished materials. Unprecedented production of passenger cars and trucks has been one of the important factors leading to the establishment of several new, high records in the iron and steel industry. May witnessed the greatest volume output of pig iron and steel ingots recorded in the history of these metals.

ACTIVITY in various industrial lines using large tonnages of castings, including the automobile, railway car, machine tool, and building fields, has incited a highly satisfactory demand for castings of all kinds. For several months, steel foundries have operated around 80 per cent and malleable shops near 90 per cent of capacity, while gray iron foundries have produced an exceptionally high volume of miscellaneous castings.

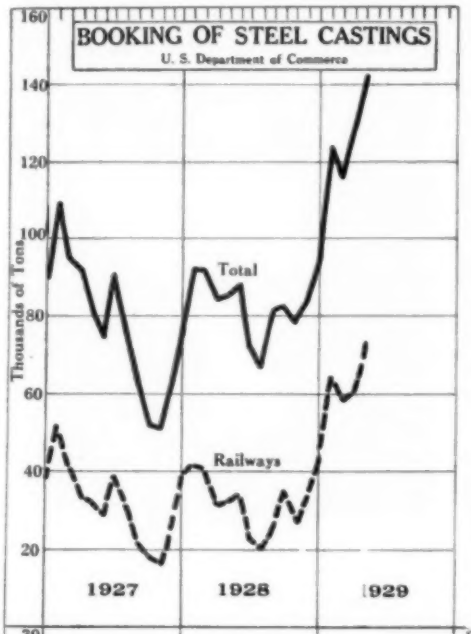
IN ANY well regulated business, high production should result in increased prices and better profits. Periods, such as the industry now is passing through, should permit the manufacturer to make a profit sufficient to carry him through times of slack demand, which appear with more or less regularity. If a foundry operating at a high capacity does not figure its costs properly, fails to add a legitimate profit in determining the selling price, or engages in an orgy of price cutting, the management is not playing fair to itself or to others in the same business. Now is the time for the foundry industry to take steps toward complete stabilization.

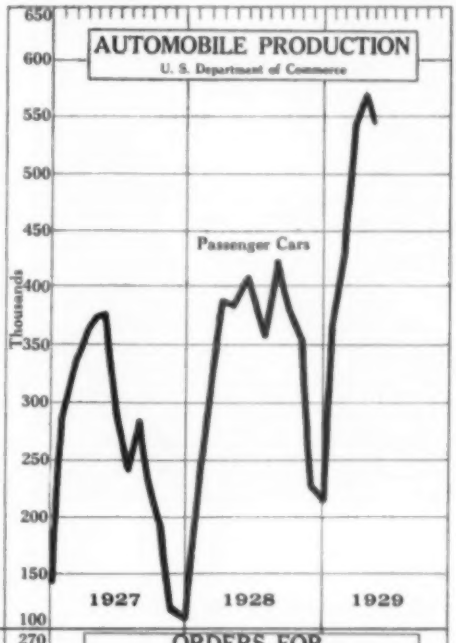
Trade Trends in Tabloid

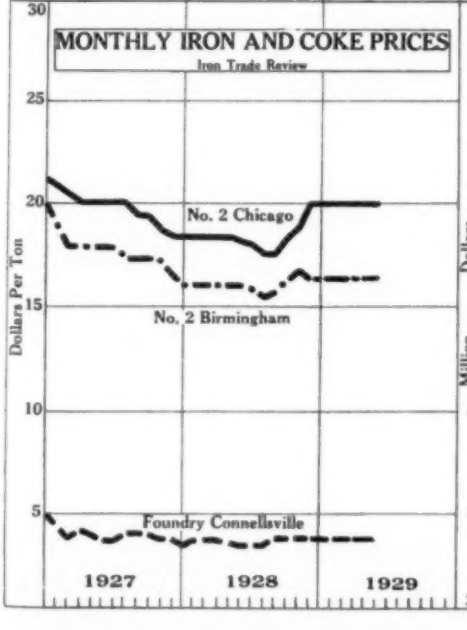
FOUNDRY operations continue at an exceptionally high rate in the face of slight recessions in several industrial lines. The predicted drop in automobile production started in May and has continued throughout June. However, production of cars in May established a record for that month, when 629,098 passenger cars were made in the United States and Canada. Automobile manufacturers expect a further decline during July, as several firms prepare for new models, but look for an upward turn around the first of August. Railway car buying, which has continued at about the same rate for two months, shows signs of increasing. Several sizable orders have been placed during the past few weeks and a large list of orders are pending. Building awards are running approximately 20 per cent behind the corresponding period last year, due especially to a slowing down in the eastern section. Awards for May in 37 states east of the Rockies totals $587,765,900. Slackness in building operations has effected shipments of sanitary ware. Foundries producing machine tool castings are reported busy. Production of malleable castings declined slightly in May when 79,805 tons were poured, as compared with 83,838 tons in April. The Ohio Foundries association reports May operations at 114.6 per cent of normal compared with 113.1 per cent of normal in April.

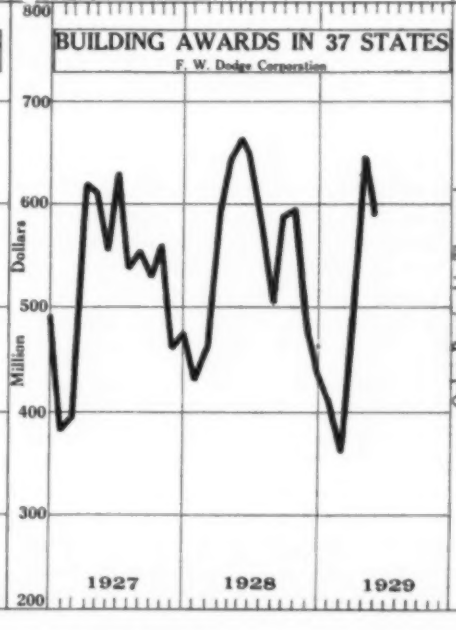
RAW MATERIAL PRICES
June 21, 1929

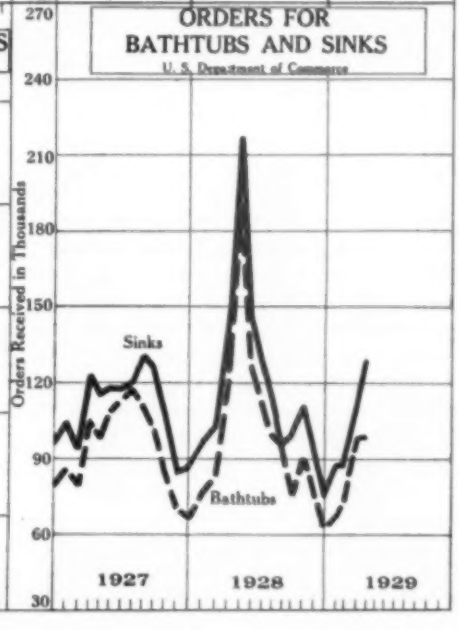
Iron	
No. 2 foundry, Valley	$18.50
No. 2 southern, Birmingham	15.00 to 15.50
No. 2 foundry, Chicago	20.00
No. 2 foundry, Philadelphia	22.26
No. 2 foundry, Buffalo	19.50
Basic, Valley	18.50
Basic, Buffalo	17.50
Malleable, Chicago	20.00
Malleable, Buffalo	20.00
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.25 to 5.00
Scrap	
Heavy melting steel, Valley	$17.50 to 18.00
Heavy melting steel, Pitts	18.00 to 19.00
Heavy melting steel, Chicago	15.00 to 15.50
Stove plate, Buffalo	12.50 to 13.00
Stove plate, Chicago	11.75 to 12.25
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.50 to 15.00
No. 1 cast, Philadelphia	16.00 to 17.00
No. 1 cast, Pittsburgh	15.00 to 16.00
No. 1 cast, Birmingham	13.00 to 14.00
Car wheels, iron, Pittsburgh	16.25 to 16.75
Car wheels, iron, Chicago	14.25 to 14.75
Railroad malleable, Chicago	18.00 to 18.50
Agricultural mal., Chicago	16.00 to 16.50
Malleable, Buffalo	18.25 to 18.75
Nonferrous Metals	Cents per pound
Casting, copper, refinery	17.37½
Electro, copper, producers	18.00
Straits tin	44.75
Lead, New York	7.00
Antimony, New York	8.87½
Nickel, electro	35.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	17.00 to 17.50
Zinc, East St. Louis, Ill.	6.70 to 6.80











Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

GEORGE R. HANKS, formerly in charge of sales and manufacturing, Taylor-Wharton Iron & Steel Co., High Bridge, N. J., has been appointed president of that company. He is 39 years old and has been in the employment of the company continuously since 1915. The Taylor-Wharton company is the oldest iron and steel business in the country having started operations

GEORGE R. HANKS

in 1742. Mr. Hanks was born at Chambersburg, Pa., where he was graduated from high school in 1906. Later he attended Mercersburg academy and Princeton university from which he was graduated in civil engineering. He joined the Taylor-Wharton organization following his graduation. Mr. Hanks served in the various departments of the plant before being appointed assistant mechanical engineer. Later he was appointed mechanical engineer but resigned in 1916 to enter the officers training camp at Plattsburgh, N. Y. However, he was recalled to High Bridge and given charge of the foundry which was producing castings for war purposes. In 1921, he was appointed superintendent of the High Bridge plant and in 1925 was shifted to the sales department. Later he was made vice president in charge of both sales and operations of the Taylor-Wharton Iron & Steel Co., and its subsidiaries. On May 24, Mr. Hanks was elected president of the company effective July 1, succeeding Percival Chrystie, who resigns after 40 years of continuous service.

George U. Harris has been elected a director of the Lima Locomotive Works Inc., Lima, O., succeeding John F. Harris, resigned.

C. A. Porrman recently was promoted from general superintendent to plant manager of the Oliver Chilled Plow Works of the Oliver Farm Equipment Co., South Bend, Ind.

J. B. Woodward has been appointed assistant general manager of the Newport News Shipbuilding & Dry Dock Co., Newport News, Va. Carl E. Petersen has been appointed assistant to the vice president in the New York office.

Joseph P. Bohn, for the past 20 years a foreman both in the iron and steel foundries of the American Bridge Co., Ambridge, Pa., has accepted a position as general foreman at the National Steel Foundries, Milwaukee. Prior to his connection with the American company, he spent some years in both iron and bronze foundries in Pittsburgh.

William B. Given Jr. was elected president of the American Brake Shoe & Foundry Co., New York, June 11, to succeed Joseph B. Terrell, who remains as chairman of the board. The board was increased to 18 and Mr. Given, Thomas Finnegan and Arthur V. Davis were elected directors. Mr. Finnegan also was elected vice president. All changes are effective July 1.

A. W. Mackay, connected with the firm of Wright, Boag & Co., general engineers, iron and brass founders, Johannesburg, South Africa, is visiting various plants in the United States to study American foundry methods and equipment. Besides the United States, Mr. Mackay has visited foundries in Holland, Italy, Bavaria, Germany, Austria, Czechoslovakia, Hungary and England.

Harry M. Hazeltine, for the past 3 years connected with the McWane Cast Iron Pipe Co., Birmingham, Ala., has accepted a position with the Fremont Foundry Co., Fremont, O. Prior to his employment by the McWane company, he was connected with Dodge Bros., Detroit, for 3 years and with the Fremont Foundry Co., Fremont, O., for 9 years. He returns to a better position with the Fremont company.

David R. Wilson, vice president and general manager of the Wilson Foundry & Machine Co., Pontiac, Mich., manufacturer of automobile castings, has been elected president and general manager to succeed Charles B. Wilson, who severs his connection with

DAVID R. WILSON

the company he helped to organize in 1914. D. R. Wilson has been in charge of the plant's operation since 1922. Albert Weber, superintendent and for 15 years connected with the company, has been elected a director. Other directors in addition to the Wilson brothers and Mr. Weber are John N. Willys, L. A. Miller, J. H. Gerkens, G. M. Mather and F. M. Jones.

Fred Delano, superintendent of the pattern shop of the Erie, Pa., plant of the General Electric Co., will retire from that position on July 1 after 22 years of service. He was born in Fairhaven, Mass. Prior to his employment with the General Electric Co. he was superintendent of the pattern department of the Brown & Sharpe Mfg. Co., Providence, R. I., for 12 years; superintendent of the pattern and maintenance of buildings departments for Pratt & Whitney Co., Hartford, Conn., for 18 months

and general factory superintendent for the Ideal Mfg. Co., Detroit, for 5½ years. Upon the announcement of his retirement, Mr. Delano was tendered a dinner by the members of the Foremen Pattern Makers' association. He organized that association and served as its head for 16 years.

William H. M. Riker, general superintendent of gray iron and malleable foundries, Eastern Malleable Iron Co., Bridgeport, Conn., has severed his connection with that firm and will engage in private practice. Mr. Riker became connected with the firm in 1902 when he joined the Wilmington Malleable Iron Works, Wilmington, Del. In 1912 he became assistant superintendent, and in 1916 he was transferred to the Bridgeport plant as general superintendent.

Professor Henry Cort Harold Carpenter honorary treasurer of the British Iron and Steel institute and a past president of the Institute of Metals is listed among those who have been knighted in connection with the king's birthday honor's list. Sir Henry was appointed head of the chemical and metallurgical departments of the National Physical laboratory at the time of its foundation. In 1905 the Carnegie gold medal for research was awarded him by the Iron and Steel institute. He is a member of the advisory council of the department of scientific and industrial research and professor of metallurgy at the Royal School of Mines, London, Eng.

Obituary

Merrill D. Mills, New York, formerly of Detroit, retired manufacturer and one of the largest holders of stove foundry stocks in America, died aboard his yacht at Miami, Fla., June 11 after an illness of several months. He was 75 years old.

George E. DeVinney, for many years owner of the foundry and machine shop at Attica, N. Y., bearing his name, died in Clearwater, Fla., where he had resided since disposing of his business and retiring, about ten years ago. He was 75 years old.

Henry W. Wendt, one of the founders of the Buffalo Forge Co., Buffalo, and its president since 1916, died June 12 at his Buffalo home, at the age of 66 years. Mr. Wendt was noted as an engineer and designer of sugar and other special machinery, in addition to being an executive of rare ability.

Ralph E. Lundgren, president, Lundgren-Stevens Co., 122 South Michigan avenue, Chicago, died June 16 after a brief illness. Mr. Lundgren was one of the organizers of the Lundgren-Stevens Co. about five years ago. He formerly had been with Charles C. Kawin Co., Chicago, foundry chemist, and also had been on the Chicago sales force of Hickman, Williams & Co.

Pulverizer Has Hammers of Alloy Steel

George F. Pettinos, 1206 Locust street, Philadelphia, has introduced an impact-attrition pulverizer for ores, limestone, coal, coke, resins, etc. Material as large as 1½ inches in size may be fed into the machine at the top and is discharged in a finely pulverized condition.

As the material is fed into the machine it falls upon the first of three, circular, steel disks spaced equally along a heavy, chrome nickel, steel shaft. The disks are bolted firmly to the shaft. Chrome nickel alloy hammers are mounted on the disks which revolve in separate pulverizing cham-

Foundry Association Directory

American Foundrymen's Association
President, S. T. JOHNSTON, S. Obermayer Co., Chicago; secretary-treasurer, C. E. HOYT, 222 West Adams street, Chicago; technical secretary, R. E. KENNEDY, 222 West Adams street, Chicago.

Associated Brass Founders of New England
President, J. A. DUNCAN, Wm. Duncan & Sons Co., 166 Liverpool street, East Boston, Mass. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen
President, J. MCARTHUR, Washington Iron Works; secretary, W. J. WARK, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club
President, H. M. HIRE, Hire Foundry Co., Peoria, Ill.; secretary, FRANKLIN WHITEHEAD, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club
President, DAVID G. ANDERSON, Western Electric Co.; secretary, ALBERT N. WALLIN, S. Obermayer Co. 2563 W. Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association
President, FRED W. STICKLE, 25 Woodrow street, West Hartford, Conn.; secretary, C. S. NEUMANN, Union Mfg. Co., New Britain, Conn. Meetings are on second Friday of each month in various parts of the state.

Detroit Foundrymen's Association
President RUSSELL M. SCOTT, Packard Motor Co., Detroit; secretary, WILLIAM J. MUHLITNER, Great Lakes Foundry Sand Co., Detroit. Meetings third Thursday in each month at appointed place.

East Bay Foundrymen's Association
Secretary O. R. MOLLER, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Gray Iron Institute
President, WALTER L. SEELBACH, Forest City-Walworth Run Foundries Co., Cleveland; Secretary, ARTHUR J. TUSCANY, Terminal Tower building, Cleveland.

Malleable Iron Research Institute
President, R. R. FAUNTLEROY, Moline Malleable Iron Co., St. Charles, Ill.; secretary ROBERT E. BELT, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association
President WILLIAM EMBER, Jefferson Brass Foundry, 62 Delevan street, Brooklyn N. Y.; secretary, WILLIAM E. PAULSON, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

Newark Foundrymen's Association
President, J. L. CARTER, Sachs-Barlow Foundries, Inc., Newark; secretary W. H. MANTZ, Atlas Foundry Co., Irvington, N. J. Meeting called by president.

New England Foundrymen's Association
President CARL S. NEUMANN, Union Mfg. Co., New Britain, Conn.; secretary, FRED F. STOCKWELL, 205 Broadway, Cambridgeport, Mass. Meetings second Wednesday of each month at the Exchange club, Boston. Outings usually are held in the summer months.

Ohio Foundries Association Inc.
President, C. C. SMITH, Toledo Steel Casting Co., Bancroft and Smead avenue, Toledo, O.; secretary-manager, E. F. SCOTT, 418 Penton building, Cleveland.

Philadelphia Foundrymen's Association
President, WALTER WOOD, R. D. Wood & Co., Philadelphia; secretary EARL SPARKS, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association
President, L. W. MESTA, Mesta Machine Co., Homestead, Pa.; secretary-treasurer WILLIAM J. BRANT, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August, at Fort Pitt hotel.

Quad-City Foundrymen's Association
President, F. W. KIRBY, John Deere Spreader Works, East Moline, Ill.; secretary-treasurer, J. P. BOADEN, Union Malleable Iron Co., East Moline, Ill. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club
President, HORACE R. CULLING, Carondelet Foundry Co., St. Louis; secretary-treasurer, LEO J. FILSTEAD, John C. Kupferle Foundry Co., St. Louis.

Southern Metal Trades Association
President, GEORGE B. COCKER, Gastonia, N. C.; secretary, W. E. DUNN JR., Healy building, Atlanta, Ga.

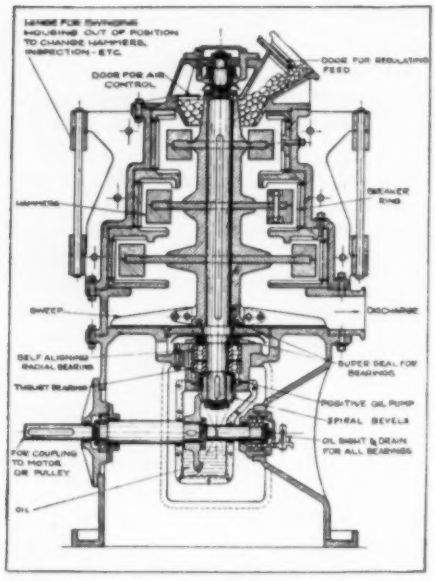
Steel Founders' Society of America
President, J. E. MCCAULEY, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.; managing director, G. P. ROGERS, Graybar building, New York.

Tri-City Technical Council
Chairman F. V. SKELLEY, Tri-City Railway Co., Rock Island, Ill.; treasurer, MAX SKLOVSKY. Deere & Co., Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association
President, WILLIAM HOPPENJANZ, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, GEORGE W. PIEHL, Wessling Bros. Foundry Co., 1607 McLean avenue. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association
President, WILLIAM E. LOBERG, American Hoist & Derrick Co., St. Paul; secretary-treasurer, C. E. LANGDON, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club
President, J. W. ORPHAN, Lake Union Foundry Co., 1703 Westlake avenue, Seattle; secretary, EDWARD C. GUSTIN, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.



THE MACHINE IS SPLIT ALONG THE CASING TO ALLOW EASY INSPECTION

bers. These chambers consist of corrugated alloy steel breaker rings concentric with the disks. Each chamber is separated from the adjoining chamber by corrugated ledge plates both at the top and bottom.

The housing of the machine is split allowing one-half to be swung out of position to facilitate inspection and repair. A horizontal shaft transmits rotation to the vertical shaft through spiral bevel gears, the ratio of which may be made to accommodate motor, turbine or belt drive. The machine is equipped with self-aligning radial bearings and thrust bearings of the heavy duty type. The bearings are equipped with individual oil pumps.

Purchasing Agents Elect

At the fourteenth annual meeting of the National Association of Purchasing Agents, held at the Hotel Statler, Buffalo, June 3-6, the following officers were elected: John R. Whitehead, Fairbanks Morse & Co., Chicago, president; Paul R. Brennan, The Stafford Co., Readville, Mass.; E. H. Weaver, Union Oil Co. of California, Seattle; W. R. Heyman, Oklahoma Gas & Electric Co., Oklahoma City, Okla.; D. B. Robinson, Tri-State Telephone & Telegraph Co., St. Paul; Joseph E. Mills, commissioner, department of purchase and supplies, City of Detroit; T. G. Elliott, Babcock-Wilcox and Goldie-McCullock Ltd., Galt, Ont., Can.; R. R. Miller, The Deming Co., Salem, O., N. B. Rhoads, board of port commissioners, New Orleans; B. C. Sawyer, Bethlehem Fabricators Inc., Bethlehem, Pa.; and R. D. Berry, Davol Rubber Co., Providence, R. I., vice presidents. Next convention of the association was awarded to Chicago, and will be held in the Stevens hotel, June 16-19, 1930.

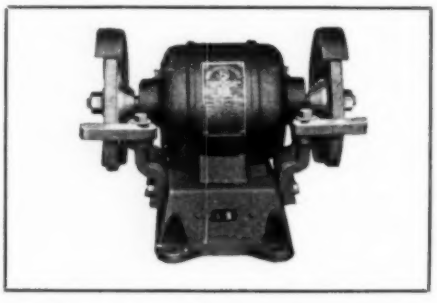
Equipment Orders Rise

The index for gross orders for foundry equipment in May was 177.7 as compared with 172.6 for April, according to a recent report of the Foundry Equipment Manufacturers association. The index of shipments for May was 217.0 as compared with 220.3 for April. Unfilled orders were 323.8 for May against 363.4 for April. The base is the average monthly shipments for the years 1922-23-24. Comparisons of monthly orders as presented by the association follow:

Month	1926	1927	1928	1929
Jan.	168.2	180.4	132.7	180.5
Feb.	154.9	198.0	123.6	197.0
March	157.3	131.1	138.6	209.4
April	113.2	130.0	107.7	172.6
May	128.5	134.8	335.6	177.7
June	133.5	138.4	149.1	.....
July	127.3	89.9	94.8	.....
Aug.	141.2	106.4	278.0	.....
Sept.	114.0	80.4	170.0	.....
Oct.	140.5	98.0	185.0	.....
Nov.	133.4	95.8	197.8	.....
Dec.	181.0	106.8	166.5	.....

Builds New Grinder

The United States Electrical Tool Co., Cincinnati, recently has introduced a new 6-inch grinder. This tool is equipped with ball bearings and has a heavy nickel steel spindle. The unit is driven by a ¼-horsepower motor traveling at 3450 revolutions per minute at load speed. The grinding wheels used are 6 x ½ x ½ inches. Adjustable tool rests and complete electrical connections are provided. The grinder is designed to use 110-volt, 60-cycle current from the light socket. If desired it may be supplied for 220 volts two or three phase, and for 110 and 220 volt direct current.



THE GRINDER IS FITTED WITH BALL BEARINGS

Change Meeting Plans

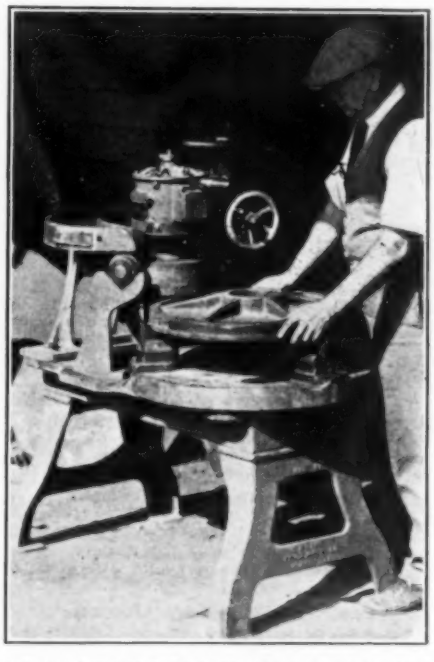
The American Refractories institute, which recently announced Pittsburgh as the place of the June 25 meeting, has changed its plans and will meet at the Hotel Cleveland, Cleveland, on the above date.

Occupies Small Space

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has introduced a new line of 300 and 400 ampere, single operator, arc welding generators of the belted and coupled type. These units may be used where driving power such as motors, gasoline engines, tractors, lineshafting, etc., are available. Speeds of 1750 and 1450 revolutions per minute, clockwise and counter-clockwise rotation provide ratings for many applications. The complete unit includes a generator, direct connected exciter, control panel and reactor. The generators have small overall dimensions to permit mounting in limited space. Control of the unit is mounted on the top of the generator frame and is enclosed in a sheet metal cabinet. The control apparatus includes a voltmeter, ammeter, and a single dial field rheostat. Welding current range of the 300 ampere unit is 90 to 375 amperes while the 400 ampere unit range is from 120 to 500 amperes.

Grinds Manhole Castings

C. H. Lyne Foundry & Machine Co., 105-109 Northwest Fifth street, Miami, Fla., recently has made changes in the design of its surfacing machine for grinding manhole rings and lids. The unit consists of a frame mounted on three wheels and a grinding wheel attached to a 2-horsepower motor. The motor and wheel may be raised, lowered or moved laterally by feed screws shown in the illustration. When grinding manhole rings the machine revolves around the ring but when it is used to grind lids, it is mounted on



MANHOLE LIDS ARE FINISHED WITH THE GRINDING MACHINE

the bed shown in the illustration, and remains stationary. The lid is rotated on the round table in the foreground. The machine is adjustable for any size manhole from 22 to 29 inches in diameter. It is designed for finishing manhole castings but may be used on other work of similar nature. The grinder also may be used as a lathe tool post grinder by detaching it from the machine. It is claimed that the machine may be operated by unskilled labor and eliminates the necessity of using valuable space in the machine shop to finish that type of work.

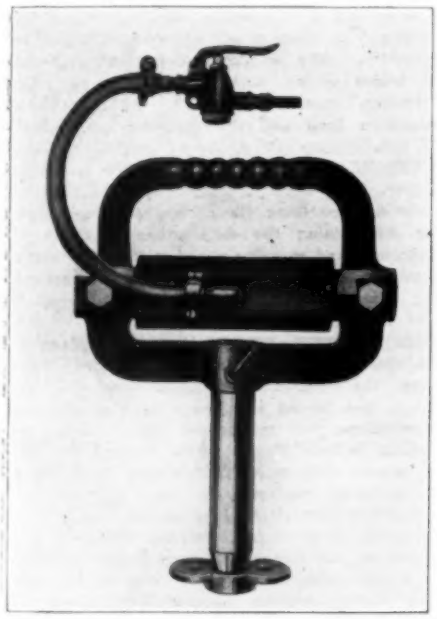
Manufacturers Organize Trade Association

Manufacturers of boilers and radiators through an executive committee formed for the purpose have organized a trade association to be known as the Institute of Boiler and Radiator Manufacturers. Membership comprises approximately 100 per cent of the manufacturers of low-pressure boilers and radiators throughout the United States.

The institute will begin operations immediately on a program of activities suggested at the trade conference of the heating and plumbing industry held by the federal trade commission at Pittsburgh May 15.

The officers of the new institute are H. T. Richardson, Richardson & Boynton Co., New York, chairman; Grant Pierce, National Radiator Corp., Johnstown, Pa., vice chairman; F. W. Herendeed, Geneva, N. Y., secretary and treasurer. The executive committee will comprise the chairman, vice chairman, the secretary and M. J. Beirn, American Radiator Co., New York; E. E. McNair, United States Radiator Co., Detroit; M. D. Rose, Pierce, Butler & Pierce Mfg. Corp., New York, and A. H. Schoth, Richmond Radiator Co., New York.

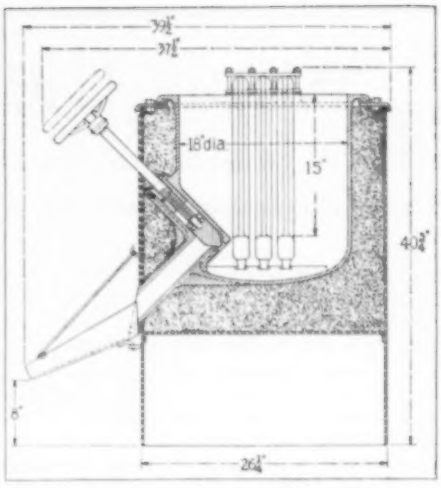
The members of the new institute are as follows: American Radiator Co., New York; United States Radiator Corp., Detroit; National Radiator Corp., Johnstown, Pa.; Richardson & Boynton Co., New York; Abendroth Bros., Port Chester, N. Y.; Molby Boiler Co. Inc., New York; Central Radiator Co., Philadelphia; Fowler & Wolfe Mfg. Co., Philadelphia; Landon Radiator Co. Inc., North Tonawanda, N. Y.; Columbia Radiator Co.; Freed Heater Co., Philadelphia; Lincoln-Niagara Corp. Inc., North Tonawanda, N. Y.; Hart & Crouse Co., Utica, N. Y.; Putnam Foundry & Machine Co., Putnam, Conn.; Raritan Radiator Co., Raritan, N. J.; Richmond Radiator Co., New York; Spencer Heater Co., Scranton, Pa.; Thatcher Co., New York; Utica Radiator Co., Utica, N. Y.; Dunkirk Radiator Co., Dunkirk, N. Y.; Pierce, Butler & Pierce Mfg. Corp., New York; H. B. Smith Co., Smithville, N. J.; Weil-McClain Co., New York; L. J. Mueller Furnace Co., Milwaukee; William H. Page Boiler Co., New York; Burnham Boiler Co., Irvington, N. J.; Federal Radiator Co., Zanesville, O.; Abram Cox Stove Co., Philadelphia; International Heater Co., Utica, N. Y.; Republic Radiator Co.; Ideal Boiler & Furnace Co.; Logansport Radiator Equipment Co., Logansport, Ind.; Prox Boiler Co., Terre Haute, Ind.; Peerless Boiler & Radiator Co., Chicago and Newport Boiler Co., Chicago.



THE VIBRATOR FITS INTO A PLUG FITTED IN THE PATTERN

Makes Pattern Vibrator

Malleable Iron Fittings Co., Branford, Conn., has introduced a new type pattern rapping and drawing vibrator. A rapping plate shown at the bottom of the accompanying illustration is fitted to the pattern on the cope half. A wooden plug is attached to this and the cope is rammed and placed on the drag. The wooden plug then is removed and the vibrator inserted in the hole so that the vibrator fits on the plug in the pattern. The air is turned on, the pattern rapped and the vibrator withdrawn. This method of rapping may be used with either split or solid patterns and tends to make a perfect match, reduce fins and chipping, reduce cleaning room costs and give a casting true to pattern. Other models are made for drawing patterns from open molds. The vibrators are made in several sizes and models.



HEATING ELEMENTS ARE LOCATED IN THE CENTER OF THE POT

Has Bottom Pour Spout

General Electric Co., Schenectady, N. Y., recently has placed a new electric metal melting pot on the market. This device as may be seen from the accompanying illustration has the pouring spout at the bottom which makes it particularly applicable where it is impractical to dip the metal or where large quantities of molten metal must be handled. The heating units are located in the center of the pot and the temperature is controlled with an automatic control panel and a temperature control instrument. The melting pot is designed for melting lead, babbitt, tin, solder, and similar alloys and metals except spelter or zinc at temperatures not exceeding 950 degrees Fahr. It is claimed that the pots heat quickly and have low radiation losses. It also is stated that heating units are replaced easily without interrupting production, and that the maximum rate of heating is obtained without overheating.

Exhibits Equipment

American Foundry Equipment Co., Mishawaka, Ind., now has a permanent exhibit of foundry equipment. It is located in one corner of the company's plant and contains a complete installation of every type of equipment that the company manufactures. The machines can be put in operation either for display purposes or for the carrying out of experiments. The original idea was to have a complete test laboratory but such interest was evinced by visitors to the plant that it was turned into a permanent exhibit. The display consists of sand cutters, sand blast equipment, dust arresters, flasks, jackets, core machines, rod straightners and other equipment.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

J. I. Case Threshing Machine Co., Racine, Wis., has changed its name to J. I. Case Co.

Empire Steel Castings Inc., Reading, Pa., has been incorporated by J. E. Horton, 146 North Eleventh street, Reading, with $5000 capital.

The Buffalo Foundry & Machinery Co., Buffalo, will erect an additional storage warehouse at its plant in Fillmore avenue, Buffalo, at an estimated cost of $25,000.

Semi-Steel Test Foundry Co., 4916 Bloomingdale avenue, Chicago, and the adjoining foundry of the Crawford Steel Co. recently were damaged by fire.

Blackhawk Foundry & Machine Co., Davenport, Ia., will build an addition, 122 x 164 feet, costing about $60,000, to its gray iron molding department. Walter K. Voss is president.

DeLaval Separator Co., Pine street, Poughkeepsie, N. Y., has awarded contract for a foundry addition to L. H. Swensen, 39 Market street. (Noted April 15.)

Great Lakes Malleable Co., 715 Clinton street, Milwaukee, will build a 1-story brick and concrete shop addition, 30 x 100 feet, at 708 Reed street.

Hayes-Custer Stove & Furnace Co., Bloomington, Ill., is planning to rebuild that part of its plant which was destroyed by fire. The loss was estimated at $100,000.

Howard Brass Foundry, 2701 Fulton street, Chicago, has moved to Franklin Park, Ill. The name of the company has been changed to Howard Foundries, Inc.

Central Foundry Co., Eighth avenue, Bessemer, Ala., will start immediate construction of an addition which will add about 3600 square feet of floor space to its main plant.

Minneapolis Electric Steel Castings Co., 3800 Northeast Fifth street, Minneapolis, has work under way on a 1-story addition, 80 x 100 feet. The building will cost about $40,000.

Members of the Manufacturers club of Wichita, Kans., recently visited the Ben Sibbitt Iron & Foundry Co., Wichita, Kans., to watch the foundry pour off a heat.

George B. Limbert, 570 Fulton street, Chicago, manufacturer of pipe fittings, advises it is improving its East Chicago, Ind. plant. It is installing a crane rail and a 10-ton crane in the foundry building as a part of the improvements.

Akron Foundry Co., Akron, Ind., recently incorporated by W. A. Gingerick with 250 shares of no par value to operate a foundry, plans construction of a building, 60 x 100 feet. Work will be started soon.

George D. Roper Corp., South Main street, Rockford, Ill., manufacturer of gas heaters, plans construction of a one and 2-story plant and office building to cost about $750,000. F. D. Chase Inc., 720 North Michigan boulevard, Chicago, is the architect and engineer.

Welland Steel Castings Co., Ltd., Welland, Ont., whose plant recently was damaged by fire, will rebuild. The new building will be 60 feet longer than the one destroyed. A new annealing oven for the heat treatment of stainless steel will be installed.

Wichita Brass & Aluminum Foundry Co., Wichita, Kans., has been absorbed by the Air Industries Foundry Co., Wichita. The brass company has moved from its location at 912 North Washington street to a new plant at 701-09 East Ninth street, Wichita.

Extruded Metal Products Co., 109 South Lincoln avenue, Wheeling, W. Va., has begun work on its new foundry. The building is a 1-story structure which together with equipment will cost $25,000. Joseph Millard is president. (Noted June 15.)

Counterflo Heater Co., 1929 South Second street, Salt Lake City, Utah, has awarded a general contract to G. H. Magdiel, 600 Northeast Capitol street, for a one-story foundry, 40 x 100 feet. The building and equipment will cost about $21,000. (Noted May 15.)

F. H. Hopkins & Co. Ltd., Montreal, Que., has been incorporated to carry on the business as iron founder, steelmaker and brass founder, with a capital stock of 2500 shares of no par value, by Rufus C. Holden, Paul P. Hutchinson, Earnest H. Cliff and others, all of Montreal.

Auto Specialties Mfg. Co., Edgewater street, Saint Joseph, Mich., will begin work soon on a 1-story addition. The building and equipment will cost about $150,000. The larger part of the new unit will be used as a foundry. F. E. Davidson, 53 West Jackson boulevard, Chicago, is the architect.

Empire Brass Mfg. Co., London, Ont., has purchased the plumbing supply business of the Canada Metal Co., Toronto, Ont., and has also taken over the sales staff of that department. The remainder of the business of the Canada Metal Co. will continue under its old management without change of policy or personnel.

Production Foundry Co., 2700 Magnolia street, Oakland, Calif., has been established for the manufacture of aluminum castings. Property has been purchased which has a total area of 14,500 square feet. The foundry department occupies 4730 square feet. The value of buildings and equipment is approximately $17,000. Leon Cameto is owner and general manager.

Mullins-Gilson Co. and Rushville Foundry Co., the latter a subsidiary of Arbuckle & Co., both of Rushville, Ind., have been merged under the name of the Mullins-Gilson Mfg. Co. The Mullins-Gilson company produces tractor accessories and disk cultivators. The foundry is to be used to produce castings for these devices. The two companies have been housed in the same building.

Sundstrand Machine Tool Co., Rockford, Ill., has bought the Rockford Union Foundry Co., of the same city and will operate it as a division. Complete reorganization and refinancing of the company has just been completed. Hugo L. Olson has been made president, Levin Faust and G. D. Sundstrand vice presidents, George A. Lindblade secretary and treasurer and G. H. Ekstrom assistant secretary and treasurer.

New Trade Publications

SWITCHES—Allen-Bradley Co., Milwaukee, is circulating a folder on the across-the-line switch that it manufactures. Some of its uses are illustrated.

SWITCHES—General Electric Co., Schenectady, N. Y., has published a 4-page folder on its magnetic switches. These may be used as across the line starters for induction motors.

TRAMRAILS—Cleveland Electric Tramrail division of the Cleveland Crane & Engineering Co., Wickliffe, O., in a current bulletin describes some of the uses of its tramrail overhead system. The folder is illustrated.

STARTERS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a leaflet on its non-reversing magnetic starters for wound rotor induction motors. The folder describes the application, operation and construction of the mechanism.

GRINDING APPARATUS—Stow Mfg. Co., Binghamton, N. Y., recently has published a folder on its portable, flexible shaft, grinding and polishing units. It contains illustrations of two types of machines and shows many of its special shape rotary files.

CRANE CHAINS—American Chain Co. Inc., Bridgeport, Conn., has prepared a leaflet giving information and data on its chains for cranes, dredges and heavy duty. It contains tables showing links per foot, weights, proof tests and safe working loads of various sizes.

LUBRICATION—Morgan Engineering Co., Alliance, O., is distributing a bulletin on lubrication with special reference to the devices it manufactures. Cranes, rolling mills, charging machines, transmissions and other machinery are included.

SKID PLATFORMS—Corrugated pressed steel skid platforms manufactured by the Lewis-Shepherd Co., Boston, are described in a current bulletin by that company. Various uses to which they can be put in industrial plants are shown.

STEEL ART CASTINGS—A bulletin issued by the Kay-Brunner Steel Casting Co., Los Angeles, Calif., describes its adaptation of steel castings to the production of decorative forms formerly produced only in wrought iron. Illustrations show results of the process in producing artistic results.

SPROCKETS—Link-Belt Co., Chicago, has published a catalog of its various types of sprockets. The catalog consists of a series of tables giving such information as pitch diameter, number of teeth, maximum and minimum bore and the diameter and length of hub.

PHYSICAL TEST APPARATUS — Adam Hilger, Ltd., London, Eng., has published two bulletins describing its photo-elastic apparatus for determining the distribution of stress in structural and machine members, and its lateral extensometer and recording device for measuring stress distribution in materials, determination of Poisson's ratio, etc.

MANGANESE STEEL—American Manganese Steel Co., Chicago and its subsidiary company, the Southern Manganese Steel Co., St. Louis, has issued an 8-page booklet on new applications for manganese steel. Uses described include dipper teeth, feeders for use in mines, skid rails, road ripper teeth, drag chains, road markers, etc.

HOISTS—American Engineering Co., Philadelphia, in a current bulletin describes and illustrates its line of electric hoists designed to handle loads from one quarter to 12 tons. The folder contains several illustrations of typical installations and also a table giving the capacities and ratings of the various hoists which that company manufactures.